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CONTENTS

The Physical Basis of Life: PROFESSOR VICTOR C. VAUGHAN 799

Ethnological Evidence that the California Cave Skeletons are not Recent: DR. C. HART MERRIAM 805

Fru Signe Rink: DR. W. H. DALL 806

Exhibit of the Bureau of Education at the Alaska-Yukon-Pacific Exposition 806

Delegates to the Darwin Celebration at Cambridge 807

The American Chemical Society: PROFESSOR CHARLES L. PARSONS 808

Scientific Notes and News 808

University and Educational News 812

Discussion and Correspondence:—

Genera without Species: PROFESSOR T. D. A. COCKERELL. *The Future of Nomenclature:* A. ARSÈNE GIRAULT 813

Scientific Books:—

Gaskell's The Origin of the Vertebrata: PROFESSOR BASHFORD DEAN. *Wenley's Modern Thought and the Crisis in Belief:* PROFESSOR ARTHUR O. LOVEJOY 816

On the Nature and Possible Origin of the Milky Way 819

Botanical Notes:—

Out of Door Botanical Study; Some South African Botany; A New Botanical Journal; Leo Errera: PROFESSOR CHARLES E. BESSEY 821

Special Articles:—

Determination of the Coefficient of Correlation: PROFESSOR FRANZ BOAS. *The Enzymes of Ova—influenced by those of Sperm:* DR. ORVILLE HARRY BROWN. *Note on Accessory Cleavage in the Hen's Egg:* DR. J. THOS. PATTERSON 823

The American Philosophical Society 826

Societies and Academies:—

The Academy of Science of St. Louis: PROFESSOR W. E. MCCOURT. *The Philosophical Society of Washington:* R. L. FARIS. *The Biological Society of Washington:* M. C. MARSH 835

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE PHYSICAL BASIS OF LIFE[1]

IT is frequently stated that the cell is the unit of life, and this is a convenient form of expression, but its exact truth depends upon the conception that one has of life. The cell may be regarded as the morphological unit of life, but form in and of itself, and as recognized by the eye, is not essential to the manifestations of life. We know no life apart from matter, and matter and energy are the only things that we do know. When matter becomes endowed with life, it does not cease to be matter; it does not lose its inherent properties; it is not released from the laws that determine its structure, its attractions and its motions. In studying the organized cell of living things, whether vegetable or animal, whether bone or brain, it should always be borne in mind that it is material in composition, subject to the fundamental laws that govern matter, and possessed of the properties essential to matter.

The only essential, characteristic and constant difference between living and non-living matter is that within the former there is constant and rhythmic metabolism, while in the latter no such process occurs. The living cell is made up of active, labile molecules and these molecules consist of numerous atoms, and each atom contains a large group of electrons; atoms and electrons are in ceaseless, rhythmic motion, while groups of atoms are being constantly cast out of the molecule and replaced by new groups split off from matter outside the molecule. Metabolism, the one char-

[1] Address of the president before the Association of American Physicians, Washington, May 11, 1909.

acteristic phenomenon of living matter, involves intramolecular change; consequently the molecule, and not the cell, is the unit of life. Matter is endowed with life when it becomes the seat of that form of energy which makes of it a metabolic mechanism. As soon as a molecule becomes the seat of assimilation and excretion it is no longer dead; it lives. As a result of assimilation, it acquires the property of building up its own substance; then polymerization follows and reproduction in its simplest form begins. The one phenomenon always manifested by living matter and never exhibited by non-living matter is metabolism. Verworn says:

> Vital motion, metabolism, is a complex motion very strongly characterizing the living organism; it consists in the continued self-decomposition of living substance, the giving off to the outside of the decomposition products, and in return, the taking on from the outside of certain substances which give to the organism the material with which to regenerate itself and grow by the formation of similar groups of atoms, *i. e.*, by polymerization. This is characteristic of all living substance.

Aristotle apparently recognized that metabolism is the one characteristic of living matter, for he said:

> Life is the assemblage of the operations of nutrition, growth and destruction.

The Greek philosopher and scientist did not know all that is now known about cells, molecules, atoms and electrons, but we must admit that he had a fairly clear conception of the most essential characteristic of living matter.

Du Bois Raymond said that the matter in crystals and non-living substances is in a condition of indifferent static equilibrium, while that in living bodies manifests a motile equilibrium. Bechterew says that we know of nothing in the inorganic world that contains or consists of motile compounds.

Matter is alive when it feeds and excretes. Crystals grow, and in a sense they multiply, but their growth is not intramolecular; it is by accretion. The living molecule not only absorbs; it assimilates. It chemically alters what it receives. The atomic groups taken into living molecules enter into new combination. The living molecule is not stable; it is highly labile. Its composition is never constant; it is never in a condition of equilibrium. There is a constant reaction between the living molecule and other molecules. This reaction consists in the absorption and assimilation of certain atomic groups and the casting out of others. Apart from other matter it could not exist.

What is accomplished by this constant interchange of atomic groups between the living molecule and outside matter? It is for the purpose of supplying the living molecule with energy. Allen expresses this fact as follows:

> The most prominent and perhaps most fundamental phenomenon of life is what may be described as the energy *traffic*, or the *function of trading in energy*. The chief physical function of living matter seems to consist in absorbing energy, storing it in a higher potential state, and afterwards partially expending it in the kinetic or active form. We find in living matter a peculiar proneness to change its composition under the stimulus of slight changes in the energy-equilibrium between itself and its surroundings, energy being readily absorbed and readily dispersed. The absorption of energy coincides with deoxidation and the building up of large molecules. The building up of these large molecules is always accomplished by slow steps; but when formed, the said molecules are very unstable, irritable or, in modern phrase, *labile*. They may be broken down by degrees in some instances; in others their structure may be so precarious as to collapse on the slightest disturbance.
>
> The lability of such a molecule may be compared to that of a house of cards, which can be taken to pieces card by card, or may collapse at once. But the word lability is applied not only to destructive, but also to constructive instability. The molecules of living substance are prone to constructive as well as destructive changes; but as in the house of cards the constructive changes

are the most gradual; and as the structure grows more complex, construction becomes more difficult, and collapse is more imminent. It should be distinctly understood, however, that it is not the mere size of the molecules that makes them labile, but rather the manner in which they are linked together and the amount of potential energy which is included in the molecule.

It is probable that in the absorption of energy by the living molecule, oxygen is released from combination with carbon or hydrogen, and is attached to nitrogen, while in the liberation of energy the inverse takes place. Nitrogen and phosphorus, sometimes with iron and manganese, seem to be, as it were, the master elements within the living molecule. It is by virtue of their chemism that groups are detached from extracellular matter, taken into the living molecule, and assimilated by an atomic rearrangement; and, furthermore, it is on account of the lability of the compound thus formed that potential energy is converted into kinetic and all work is accomplished.

Life is function and not form, and moreover it is a molecular function. The cell is made up of many and possibly of diverse molecules, but it is the function of the intracellular molecules that determines the nature of its activities. The following quotation from Nussbaum, as given by Loeb, shows that the biologist recognizes that the cell is not the unit of life.

The cell is not the ultimate physiologic unit of life, even though it must remain such for the morphologist. We are, however, not able to tell how far the divisibility of a cell goes, and how we can determine the limit theoretically. Yet, for the present, it will be well not to apply to living matter the conceptions of atoms and molecules which are well defined in physical chemistry. The notion, Micella, introduced by Naegele, might also lead to difficulties, as the properties of living matter are based upon both nuclein and protoplasm. The cell consequently represents a multiple of individuals.

Pflüger has shown that the egg, which has been thought to be a biologic unit, can give rise to many individuals, and Loeb states that his own experiments, as well as those of Driesch, confirm this finding.

In his interesting monograph on the "Biogen Hypothesis," Verworn objects to saying that a molecule lives. He states that this is illogical.

A living thing is only that which demonstrates the phenomenon of life—something that changes itself. A molecule of a given compound, so long as it remains unchanged, can not be said to be living.

Then, in order not to speak of living molecules, he introduces the term "biogen molecule." Surely, this is a distinction without a difference. I agree with the distinguished German physiologist that a molecule of a cell, so long as it remains unchanged, can not be said to be living, but the point is that living molecules do not remain unchanged. When life is latent, as it is in spores, seeds and ova, the molecule can not be said to be alive, neither are the cells alive; but when placed under favorable conditions, the change between atomic groups in the molecule and the extracellular food substance begins, and life manifests itself. A seed contains the germinative cell, a specific ferment and the stored food. The seed is not alive; it possesses only latent life. So long as it remains merely a seed the ferment has no action on the stored food, but place it under suitable conditions of temperature and moisture and the ferment begins to break down the stored protein, and as a result of the chemical cleavage induced by the ferment, relatively simple nitrogenous bodies, such as the mono-amino acids, tyrosin and leucin, and the diamino bodies, arginin and lysin, are formed. These substances begin to react with the molecules within the germinative cell, and latent life is quickened into the active form; the mechanism begins to

work and growth commences. Many of the lower forms of life can not feed upon the proteins. This is true of the yeast cell. These cells grow rapidly when placed in a solution of sugar and nitrates, but proteins must be broken up by putrefactive bacteria before yeast organisms can feed upon them. Indeed, many of the cells in the body of man can not feed upon the complex proteins, which must be split up into simpler groups by the digestive enzymes before the cell molecules can absorb and assimilate them. Even the carbohydrate starch must be hydrated and its elements rearranged as the constituents of a more labile molecule before it can become a source of energy in muscle. Solutions of proteins injected into the blood of man are poisonous, but the same substances, after being properly split up, are valuable sources of energy, and some are essential to the continuance of those functions that constitute life.

The atomic groups cast out from the living molecule are not altogether waste products, for among them are the specific secretions which act upon the extramolecular substance, and fit it for absorption and assimilation. Many of these substances have a reversible action. The colon bacillus will feed at one time on solutions of highly complex proteins, the secretion splitting up the large molecule into smaller groups, thus acting as an analytical agent. The same bacillus will grow in a medium that contains available nitrogen only in the form of amino-acids, its secretion acting as a synthetical agent and building up complex bodies out of simpler ones. It is by means of the specific secretion that the living cell, or the molecules of which it is composed, feeds, or, in other words, breaks up the pabulum placed within its reach into groups suitable for absorption or assimilation. In case of fixed cells the food stuff must be brought to the cell or within close range of it before it can be prepared for assimilation. Life in a cell molecule ceases when food is withdrawn, or when the secretion is wanting, or from any cause made inactive. No living molecule can continue to function when new material is wanting. Each living, acting molecule has a selective action in the assimilation of new material, and this is quite indicative of metabolism being a chemical or intramolecular process. It might be supposed that a living molecule is a highly complex body, possibly with many basic and many acid groups. In the process of metabolism an acid group is cast out and this enters into one of the molecules of the foodstuff, setting free another acid group which takes the place of the group cast out. In this way the living molecule feeds, regenerates itself, and supplies itself not only with new matter but with energy. These movements are rhythmical and continue in the same tempo so long as conditions remain the same. It may be that groups of different sizes are cast out and replaced from time to time, smaller groups being thrown off more, and larger ones less, frequently. We have reason for believing that in many living molecules there are at least two kinds of metabolism which occur simultaneously, but in different tempo. The more frequent consists in casting out from the living molecule relatively small groups consisting largely of oxidation forms of carbon and hydrogen. The less frequent is a nitrogenous metabolism in which urea or some antecedent of this substance is eliminated and is replaced by fresh material. It is possible that individual molecules are broken up beyond repair in the nitrogenous metabolism, the worn-out one having already reproduced its successor by polymerization. The tempo with which these processes of metabolism occur may be altered by changing the external conditions. When the speed is too

great or when it is too slow continued metabolism, or life, may be endangered. The tempo is altered when it becomes necessary for the living matter to do work. More energy must be absorbed, the greater the work done, and this needed increase in energy can be secured only by increasing the speed with which the metabolic process takes place.

I wish to call attention to the fact that in even the simplest unicellular organism its normal processes are purposeful. The cell molecules attract substances that serve them best as foods. From these they select the parts that they can utilize, and reject the parts that can not serve them. This is true, however, only within certain limits, because often they do absorb substances that lead to their own destruction. Their selection seems to be guided by chemism, which on the whole leads them in the safe way, but may cause their destruction.

It is not my purpose to discuss at this time the question of the relation between the existence of a nervous system and conscious action or psychical activity, but I do wish to call attention to the fact that low forms of life in which there is no trace of nerve tissue behave in a purposeful manner. Many of the low forms of life in which there is no trace of the development of the sense of sight, or sound or feeling, are responsive to light, to sound and to stimulation. We see most convincing evidence of this in the phenomena of helio-, thermo-, chemio- and galvano-tropism. Under the influence of optical, thermic, chemic and electric stimuli these low forms of life, devoid of any trace of nervous system, manifest movements that serve them in self-protection, in securing food and in reproduction. These lower forms of life without nerve tissue apparently learn by experience to choose between what is good and what is bad for them. Metalnikov placed carmin in a fluid in which ciliated infusoria were swimming. At first they absorbed the carmin granules, but having done so once, they could not be induced to try this food again. This behavior, it must be admitted, is much the same as that of the dog which, having been struck with a stick once, runs away when he again meets the same man with a stick. Certain infusoria that feed upon bacteria select the species upon which they feed. The movements of infusoria in pursuit of their prey are certainly purposeful, if not conscious. The readiness with which low forms of life accommodate themselves to altered environment shows that they are capable of being trained or educated to a certain extent. Stahl has shown that a certain plasmodium flees when sprinkled with salt, but if the salt be added to the medium gradually the organism accommodates itself to the new medium. Purposeful action is manifested by plants as well as by animals, and by both unicellular and multicellular plants. This is in evidence in the movements of algæ and moulds. Leaves turn toward the sources of light and heat, and the roots seek nourishment in the earth. The capability of responding to certain stimuli is common to all cell life, whether it be vegetable or animal.

In multicellular animals, such as man, we have colonies, or groups of cells, or organs, bound together. Each kind of cell has its own peculiar molecular composition and through these living molecules the work of the organ is accomplished. A framework of bone, cartilage and connective tissue support and hold in position these organs. They are supplied with food material by a common system of blood and lymph vessels, and their harmonious action is secured through the nervous system. The digestive organs roughly prepare the food for all, but each has its own secretion

which shapes the pabulum for intramolecular assimilation. This is accomplished in both instances by means of specific ferments that are formed within the cell molecules. These enzymes bring about changes in the pabulum at the relatively low temperature of the body which can be wrought by inorganic chemicals only at much higher temperature and after prolonged action.

The cell molecules in each organ of the higher animals have their own peculiar composition and manifest their own peculiar function. The chemical composition of the liver differs from that of every other organ in the body. The liver cell molecules cast out their own characteristic products and absorb and assimilate special atomic groups. Moreover, the tempo of metabolism probably differs in each organ, or at least the cell molecules of each organ have their own optimum tempo to which their metabolic processes conform. The more complicated the structure of the cell molecule, the more energy may be stored in it, the greater its lability and the greater is its susceptibility to altered conditions. In the nervous system the molecular structure is the most complex, the amount of stored energy is at the maximum, and the readiness with which this energy may be released is most manifest. In the active central nervous system, or the brain, we have the highest manifestation of the molecular functions that characterize life. The molecules that make up this structure are most susceptible to alteration in conditions. In their function they are influenced by slight disturbances in other organs. We have heard much of late concerning the influence of mind upon the body, and many who speak upon this subject seem to assume that there is some entity, called mind, that controls the body to which it is superior, and apart from which it may exist. This dualistic doctrine is as old as the philosophy of Plato; it always has been and remains to-day a dogma without scientific support, and as a hypothesis it has led to the discovery of no scientific fact. Every attempt to apply it to the treatment of disease has led to the development of conscious or unconscious charlatanism, and has resulted in more or less marked atavism. The term functional disease is now being used by those who know but little concerning the functions of the body in either normal or abnormal states. It seems to be inferred or assumed by those using this expression that a mysterious power has been given to some to set the mechanism of the disordered body aright, although those supposed to be possessed of this gift have no knowledge of, or but imperfect and superficial acquaintance with, the functions of the various organs and their interrelations. In truth we have no evidence of the existence of a functional disease as thus understood. In health the several organs of the body function harmoniously; in disease there is lack of perfect harmony, and we know of no disease in which this condition does not exist. We may not always be able to find where the basic fault lies, but shall we for this reason stop looking for it, shut our eyes, give over our search and ask some individual, quite ignorant of the body and its functions, to undertake the task of inducing harmonious activities? Of mind apart from the body we know nothing. Of the brain as one of the correlated organs we know something, and by continued and patient research we hope to learn much more. We do know that the cell molecules of the brain are the most complex, the most highly labile and the most susceptible to external influences of any of the structures that constitute that community of organs which makes up the individual. We know that the introduction of such poisons as alcohol, morphine and cannabis indica

into the blood, leads to disorder of cerebral function; that failure to function properly on the part of the liver, kidney, spleen or other organ, modifies the activity of the brain; and that, on the other hand, altered function in the brain may disturb the functions of these other organs. The medical profession is fully aware of the fact that man thinks not only with his brain, but in a certain sense with every organ in his body. In other words, we know that the perfection of activity of the brain is modified and determined by the proper and healthy activity of other organs of the body, although we are ready to admit that our knowledge along this line is by no means complete. We have studied in myxedema the effect of disordered function in the thyroid upon the central activity. We have learned that in chronic malaria, the central activities, the ideals and the philosophy not only of the individual but of nations, may be debased; that in uncinariasis and other forms of parasitism like results may follow. In short, medical observation and study have shown that healthy cerebral function is to be found only when the activity of the brain is properly influenced by normal function of all the correlated organs. We know equally well the influence of the brain on the other organs of the body. We are fully aware of the fact that impulses may be started in the brain through any of the five senses that may favorably or unfavorably influence the activities of correlated organs, and for centuries the medical profession has employed this physiological principle in the treatment of disease. Savory dishes, pleasingly garnished, through the sense of sight and smell tempt the appetite and stimulate the flow of the digestive juices. Cheerful surroundings aid digestion. Cheering words improve the circulation, and hope is often the best tonic that the physician can administer. As I have stated, the medical profession has understood and has utilized these physiological facts for centuries, and there is nothing in them to justify the founding of any new cult. That the brain of one individual may be modified in its activity by the sounds that fall from the lips of another is as much of a physical fact as that of the contraction of a muscle by the passing of an electric current through its nerve. There is nothing in this to justify a dualistic doctrine involving the existence of mind apart from and superior to matter. Indeed, every step in the process is in accord with the laws of physics and chemistry. The vocal organs of the speaker set in motion the sound waves that strike upon the ear of the hearer, the auditory nerves carry the impulse to the brain center, and the brain molecules respond. There is nothing in it that the most materialistic of philosophers might not endorse. Sensibility, or the capability of responding to stimuli, is, as Claude Bernard said, to a certain extent the starting-point of life; it is a primary phenomenon and from it all others, physiological, intellectual and moral, develop. Bechterew holds that irritability or sensibility is due to a motile cohesion in the biomolecule, and that psychical activity is the result of a complex function of this molecule. Since nothing comes from nothing, the basis of psychical action must lie in the physico-chemical elements of the organism.

VICTOR C. VAUGHAN
UNIVERSITY OF MICHIGAN

ETHNOLOGICAL EVIDENCE THAT THE CALIFORNIA CAVE SKELETONS ARE NOT RECENT

SINCE the discovery of the celebrated Calaveras skull, many human skulls and skeletons have been found in caves along the west slope of the middle Sierra.[1] The presence of human

[1] See Sinclair, *Univ. Calif. Pubs.*, Am. Arch. and Eth., Vol. 7, No. 2, 1908.

remains in these caves has been interpreted to mean that the Indians now living in the region practise cave burial, or did practise it until recent times. This is an error. The Indians of this region, the Mewuk, burned their dead, and never under any circumstances put them in caves. These Indians believe the caves to be inhabited by a stone giant, whom they call Chehalumche, who sallies forth at night in search of food. He preys, by preference, on people, but when he can not get people, takes deer or other animals. He never eats his victims in the open but carries them into the caves and there devours them. Members of several subtribes of the Mewuk have told me this, and have looked with horror on the suggestion that they or their ancestors might ever have put their dead in caves. They say: "Would you put your mother, or your wife, or your child, or any one you love, in a cave to be eaten by a horrible giant?" The idea is so abhorrent to them that the theory of cave burial must be abandoned as preposterous. The Mewuk feel that the finding of human bones in these caves must convince us of the truth of their belief in the occupancy of the caves by Chehalumche, the bones being those of the victims he has carried there.

The mythology of the Mewuk does not admit of any migration but describes the creation of the people in the area they still inhabit. This, in connection with the fact that these Indians speak a language wholly different from any known in any other part of the world, proves that the Mewuk have occupied the lands they now occupy for a very long period—a period which in my judgment should be measured by thousands of years.

This argues a great antiquity for the cave remains, for they must be those of a people who inhabited the region before the Mewuk came—and this takes us back a very long way into the past.

C. Hart Merriam

FRU SIGNE RINK

We regret to announce the death, April 19, in Kristiania, Norway, of Fru Signe Rink, widow of the late H. Rink, formerly Danish governor of Greenland and supervisor of the Greenland commerce; and known all over the world for his valuable contributions to the ethnology of the natives of Greenland and the Eskimo people generally. Fru Rink survived her husband many years, and was the author of several little books and other writings on the tales, home life and traditions of a people with whom she had a partial connection by blood. Probably no one in Europe had a more intimate knowledge of their character, though it was with difficulty she could be persuaded to the publicity of authorship. Personally she was of a most kindly, hospitable and vivacious disposition, and her death will leave sorrow in many hearts. A daughter resident in Kristiania survives her. W. H. Dall

EXHIBIT OF THE BUREAU OF EDUCATION AT THE ALASKA-YUKON-PACIFIC EXPOSITION

The plans of the National Bureau of Education for an exhibit at the Alaska-Yukon Exposition have been formed with special reference to the interests of teachers and officers of education.

In the section assigned to the bureau in the government building, a conference room has been fitted up where visiting educators will find ready welcome. Here they may consult publications pertaining to current movements in education, and a select reference library for teachers. The classified catalogue of this library will be furnished upon request. Arrangements for professional conferences in this room at stated hours may be made if desired.

The space surrounding the conference room is given up to exhibits pertaining to movements for the uplift and extension of rural education. These exhibits illustrate what is actually being done for the improvement of rural schools in the more progressive communities, and thus by concrete examples suggest the means of meeting needs which are felt in every part of the country. The separate exhibits have been prepared under the direction of a committee of the bureau appointed by the Commissioner of Education, assisted by expert collaborators in different sections of the country.

Special interest attaches to exhibits presenting typical courses of instruction in art, in nature study and in geography, prepared by authorities in these respective branches who are also masters of the art of graphic presentation.

Manual training, as carried out in the rural high schools, which are rapidly increasing in number, is well represented in the section. The importance of this training is emphasized by a typical course of manual training exercises equally adapted to city and country high schools, arranged for this occasion by Dr. Calvin M. Woodward.

The absorbing interest in this country at the present time in the development of high schools in which provision is made for agriculture, domestic science and manual arts, is emphasized in the exhibit by material pertaining to these subjects as parts of the school curriculum. This material consists of monographs, leaflets and photographs by means of which every phase of this comparatively recent departure in our educational provision is illustrated.

The equipment of rural schools is vastly increased by traveling and loan museums of which important examples have been supplied to this exhibit from the National Department of Agriculture, and from the chief scientific museums of the country which are rapidly coming into the same relation with the common schools as the traveling libraries.

The entire exhibit is arranged around two centers, as it were, namely, the model of an improved type of rural school, and a graphic presentation of the consolidated rural school. This plan emphasizes the fact that the first condition of improvement in common schools is their suitable housing.

The different collections in the exhibit are all fully labeled, and credit is given in each case to the source from which the particular exhibit was derived.

It is hoped that all teachers and school officers visiting the exposition will avail themselves of the opportunity thus afforded by the National Bureau for the study of salient educational problems of the hour, and also for professional meetings and conferences.

Special appointments for the conference room, and documents intended for circulation may be secured by addressing Mr. James C. Boykin, acting representative of the Interior Department at the Alaska-Yukon Exposition.

DELEGATES TO THE DARWIN CELEBRATION AT CAMBRIDGE

THE following is the list of American institutions which have been invited to send delegates to the celebration to be held in Cambridge next month in honor of the Darwin centenary and of the delegates who have been appointed:

Ann Arbor, University of Michigan, Dr. H. S. Carhart.
Baltimore, Johns Hopkins University, Dr. J. M. Baldwin.
Berkeley, University of California, Dr. Jacques Loeb.
Boston, *American Academy of Arts and Sciences, Professor W. Gibson Farlow.
*Boston Society of Natural History, Professor C. S. Minot.
Cambridge, Harvard University, Dr. A. Agassiz and Dr. Theobald Smith.
Charlottesville, University of Virginia,
Chicago, University of Chicago, Professor J. M. Coulter.
Evanston, Northwestern University,
Cold Spring Harbor, Station for Experimental Evolution, Dr. C. B. Davenport.
Columbus, Ohio State University,
Indiana, *Franklin Literary Society,
Ithaca, Cornell University, President J. G. Schurman.
Madison, University of Wisconsin, Dr. F. B. Powers.
Minneapolis, University of Minnesota, Professor E. van Dyke Robinson.
New Haven, Yale University, Professor R. H. Chittenden.
Connecticut Academy of Arts and Sciences, Professor Tracey Peck.
Peabody Museum of Natural History, Professor R. H. Chittenden.
New York, Columbia University, Dr. E. B. Wilson.
New York University, Dr. H. M. Biggs.
*New York Academy of Sciences, President C. F. Cox.
American Museum of Natural History, Director H. C. Bumpus.

Palo Alto, Stanford University, Professor V. L. Kellogg.
Philadelphia, University of Pennsylvania, Dr. C. C. Harrison.
*Academy of Natural Sciences, Dr. A. E. Brown.
*American Philosophical Society, Professor H. F. Osborn.
Pittsburg, Carnegie Institute, Dr. Samuel Harden Church.
Princeton, Princeton University, Professor W. B. Scott and Professor W. O. Richardson.
San Francisco, *California Academy of Sciences, Dr. G. E. Hale.
St. Louis, Washington University,
Washington, Smithsonian Institution, Dr. C. D. Walcott.
Carnegie Institution, Dr. R. S. Woodward.
Academy of Sciences, Dr. L. O. Howard.
U. S. Geological Survey,
The George Washington University,
Department of Agriculture,
Woods Hole, Marine Biological Laboratory, Dr. E. B. Wilson.

* Societies of which Charles Darwin was an honorary member.

AMERICAN CHEMICAL SOCIETY

The summer meeting of the American Chemical Society will be held in Detroit, Mich., June 29 to July 2, and there is every prospect that the meeting will be one of the most largely attended and successful in the society's history. The local society of Detroit chemists is putting forth every effort to insure a successful gathering. One day of the meeting will be spent in Ann Arbor as the guests of the University of Michigan.

The council of the society will meet on June 28 and the opening session of the general meeting will be on the morning of June 29 in the Central High School which offers every facility for the meeting of the various divisions and sections of the society.

The Hotel Pontchartrain has been selected as headquarters for the meeting.

Titles of papers to be read at the summer meeting should be sent to the secretary of the society or to the secretaries of divisions and to find place on the program should reach me on or before June 7. Papers for the section of chemical education should be sent to the chairman, H. P. Talbot, Institute of Technology, Boston, Mass., before June 5.

A full program of the meeting will be sent to all members of the society about June 20.

Charles L. Parsons,
Secretary

Durham, N. H.

SCIENTIFIC NOTES AND NEWS

At the last meeting of the American Academy of Arts and Sciences, it was voted to award the Rumford premium to Professor Robert W. Wood, of the Johns Hopkins University, for his discoveries in light and particularly for his researches on the optical properties of sodium and other metallic vapors.

At the last meeting of the Rumford committee of the American Academy the following grants were made: To Professor M. A. Rosanoff, of Clark University, for his research on the fractional distillation of binary mixtures, $300; to Professor C. E. Mendenhall, of the University of Wisconsin, for his research on the free expansion of gases, $300.

Professor F. W. Putnam has been elected honorary member of the Societa Italiana d'Anthropologia, Ethnologia e Psicologia Comparata of Florence, Italy. Since 1887 he has been a corresponding member of this society.

Dalhousie University has given its doctorate of laws to Dr. A. Ross Hill, president of the University of Missouri, who graduated from Dalhousie in 1892.

Professor R. Meldola, F.R.S., has been elected a member of the Athenæum Club for scientific eminence.

The Marine Biological Station of San Diego having developed to such an extent as to require the entire time of the scientific director; and having been so endowed as to make it possible for him to devote himself to it, the present director, Professor Wm. E. Ritter, will relinquish the active headship of the department of zoology in the University of California at the close of the present academic year and will take up his permanent residence at the station. After June 1 his address will be, therefore, La Jolla, California.

DR. E. E. SOUTHARD has been appointed pathologist to the Massachusetts Board of Insanity, from May 1, 1909. The position is a new one in Massachusetts. The appointee will be required "to visit the different institutions from time to time as the representative of the board, with particular reference to the supervision of clinical, pathological and research work, and, so far as possible, in an advisory capacity, to stimulate interest, coordinate efforts and promote the best results in this direction."

PROFESSOR E. T. ROBBINS, assistant animal husbandman, Iowa Experiment Station, has accepted a position on the editorial staff of the *Breeders' Gazette,* Chicago, Ill.

A GEODETIC survey department for Canada has been established under Dr. W. F. King, chief astronomer of the dominion.

DR. HEINRICH RIES, professor of economic geology at Cornell University, has been commissioned by the Canadian government to make a survey of the clay deposits of Canada.

THE University of Pennsylvania has granted leave of absence until October 1, 1910, to Philip P. Calvert, Ph.D., assistant professor of zoology, to enable him to go to Central America to pursue further researches on the ecology of tropical Odonata. This is in continuation of the studies which have grown out of his preparation of the account of these insects for the *Biologia Centrali-Americana.* Dr. and Mrs. Calvert sailed from New York on April 17 for Costa Rico.

DR. CARL LUMHOLTZ has gone to the arid regions of Sonora and the upper part of Lower California to make ethnological research among the Pina, Papago and Cocopa Indians. He will also study the physical geography of the little-known region between Rio de Altar and the mouth of the Colorado River. Dr. Lumholtz will be gone until next winter, returning in February or March.

DR. RAYMOND F. BACON, of the chemical division of the Bureau of Science, Manila, is spending five months in this country.

PROFESSOR VON RUNKER, director of the Agricultural Institute of Breslau, Germany, and Professor Erich Tschermakedeer von Seysenegg, of the College of Agriculture, Vienna, Austria, have been sent by their governments to study agricultural experiment stations in the United States.

PROFESSOR CHARLES BASKERVILLE, director of the chemical laboratory, College of the City of New York, sailed for London on May 15 on the steamer *Kroonland,* to attend the Seventh International Congress of Applied Chemistry. He will be abroad all summer.

DR. MAX MEYER, professor of experimental psychology in the University of Missouri, will leave toward the end of May for a year's stay in Europe on leave of absence.

DR. A. LAWRENCE LOWELL, president-elect of Harvard University, will give the Phi Beta Kappa address at Columbia University on June 1, at 4:30 in the afternoon. The subject will be "Competition in College."

PROFESSOR RAYMOND DODGE gave an illustrated lecture on "The Nature and Practical Importance of Fatigue," before the Middletown Scientific Association on May 11.

PROFESSOR ROBERT FLETCHER, of the Thayer School of Civil Engineering at Dartmouth College, will give the memorial address at the Rose Polytechnic Institute of Terre Haute, Ind., on June 8. The occasion is the graduation of the twenty-fifth class, and the commemoration of founders day.

PROFESSOR JOHN C. OSTRUP, of Stevens Institute of Technology, delivered an address before the Canadian Society of Civil Engineers at Montreal, Canada, on the evening of May 6. The subject was "Some Features of the Design and the Construction of the Manhattan Suspension Bridge." The address was illustrated with lantern slides and brought out a spirited and interesting discussion.

AN anonymous benefactor has expressed his willingness to contribute a sum of £500, or so much of this sum as may be required, to supplement the £500 which the senate has voted towards defraying the cost of the Darwin commemoration at Cambridge.

DR. F. G. YEO, F.R.S., emeritus professor of physiology in King's College, London, has died at sixty-four years of age.

The late Mr. W. H. Hudleston, the eminent geologist, has left his unrivaled collection of types of Oolitic Gasteropoda to the Sedgwick Museum, Cambridge, and £1,000 to the Geological Society.

The University of Colorado has received an interesting collection of fishes from the river Nile, presented by the Egyptian government through Dr. Boulenger, of the British Museum.

We learn from *Nature* that at a special general meeting of the Zoological Society on April 29, it was decided to dispose of the site of the society's freehold premises in Hanover Square, and to expend the proceeds upon the erection of new offices, library and meeting-room at the Zoological Gardens in Regent's Park, and on the general improvement of the gardens.

It is expected that the Marine Laboratory of the Johns Hopkins University will be reopened in Jamaica in 1910, so that graduate students and instructors will have the opportunity to study marine and mountain flora and fauna in the tropics and to obtain material for research problems.

On May 8 the Theta Chapter of Alpha Chi Sigma, the national chemical fraternity, was installed at the University of Nebraska by Dr. J. H. Mathews, of the University of Wisconsin, and Mr. L. S. Palmer, of the University of Missouri. The following men constitute the new chapter: Professor Benton Dales (director), Professor George Borrowman, Jr., P. B. Barker, O. L. Barneby, H. J. Broderson, M. R. Daughters, C. J. Frankforter, R. L. George, L. F. Gieseker, W. L. Hadlock, F. C. Hawks, W. D. Jensen, S. A. Mahood, G. R. McDole, W. H. Warren, A. L. Weaver and E. F. Wilson. Alpha Chi Sigma is a professional chemical fraternity, organized in 1902, with the purpose of promoting a fraternal spirit among chemists, of providing a reward for faithful undergraduate work and of providing a closer relationship between alumni and students. It now has chapters at the University of Wisconsin, University of Minnesota, Case School of Applied Science, University of Missouri, University of Indiana, University of Illinois, University of Colorado and University of Nebraska. A chapter will shortly be installed at the Rose Polytechnic Institute.

The annual dinner of the Syracuse Chapter of Sigma Xi was held at the St. Cloud Hotel on May 13. Research reports were called for as follows: department of astronomy, Professor H. A. Peck; chemistry, Professor E. N. Potter, zoology, Professor C. H. Richardson; mathematics, Professor W. H. Metzler; botany, Professor W. L. Bray. Professor E. N. Pattee was elected president; Dr. H. D. Senior, vice-president; Professor C. H. Richardson, secretary, and Professor F. F. Decker, treasurer. Mr. E. C. Keenan and Mr. N. E. Loomis were elected to membership as graduate students.

The fourth meeting of the Research Workers in Experimental Biology of Washington was held at the Medical School of George Washington University on May 1. Dr. Oswald Schreiner, of the Bureau of Soils, spoke on "Some Factors of Soil Fertility." The lecturer laid special emphasis upon the influence of organic matter of the soil with reference to the biochemical relationships which exist between soil and crop and the microorganisms within the soil. The influence of organic compounds isolated from the soil on plant growth was illustrated by lantern slides and photo-micrographs of the crystalline materials were also shown. The lecture was followed by discussion.

Mr. Henry P. Phipps was formally presented on May 12 with the gold medal awarded him by the International Anti-Tuberculosis Association for his aid in waging war against consumption. The presentation was made by Dr. Lawrence F. Flick, at a dinner tendered at the Bellevue-Stratford in Philadelphia. Mayor Reyburn presided and the speakers were introduced by former Ambassador Tower. Mr. R. W. DeForest, president of the New York Charity Organization Society, responded to the toast "Henry Phipps, Citizen of New York," Hon. H. D. Harlan, chief judge of the supreme bench, spoke on "Henry Phipps, benefactor, of Baltimore." Dr. William J.

Holland, director of the Carnegie Museum, spoke on behalf of Pittsburgh and Dr. Talcott Williams, on "Henry Phipps, a native of Philadelphia."

LORD AVEBURY took the chair at the annual *conversazione* of the Selborne Society on May 7. Two lectures were given, the first on "How Birds Fly," by Mr. F. W. Headley, F.Z.S., science master at Haileybury College, and the second on "How Men Fly," by Mr. T. W. K. Clarke, A.M.I.C.E., the first engineer to build aeroplanes in Great Britain. Mr. James Buckland exhibited a number of lantern slides illustrating the birds that are in danger of extermination in various parts of the world. There was also a display of microscopes and natural history exhibits.

THE seventy-seventh annual meeting of the British Medical Association will be held in Belfast on July 23–31. The president-elect is Sir William Whitla, professor of materia medica and therapeutics, Queen's College, Belfast. The address in medicine will be delivered by Dr. R. W. Philip, that in surgery by Professor A. E. J. Barker, and that in obstetrics by Sir John W. Byers. The popular lecture will be delivered by Dr. J. A. Macdonald.

NEWS has been received from Dr. Charcot's Antarctic expedition which has arrived at Deception Island, one of the South Shetland group, on December 22. The *Pourquoi-Pas* left the island on Christmas day for Port Lockroy, from which it was to proceed to the south. Dr. Charcot hopes to establish his winter quarters on Alexander Land, the name given to the region lying to the south of Graham Land in about 70° south latitude, which will form a point of departure either for exploring the coast line towards King Edward VII. Land or for penetrating into the interior. No further news may be expected from Dr. Charcot for at least a year.

A NATIONAL conference on criminal law and criminology in celebration of the fiftieth anniversary of the founding of the Northwestern University School of Law will be held in the Northwestern University building, Chicago, on June 7 and 8.

THE annual meeting of the Naples Table Association for Promoting Scientific Research by Women was held on April 24 by invitation of Director Bumpus, at the American Museum of Natural History. Miss Caroline McGill, of the University of Missouri, was appointed a scholar of the association at the Naples Station. The award of the prize of one thousand dollars offered every second year for the best thesis written by a woman on a scientific subject, embodying new observations and new conclusions based on an independent laboratory research in biological, chemical or physical science, was made to Miss Florence Buchanan, D.Sc., of London University, fellow of University College, London, for a thesis entitled "The Time taken in the Transmission of Reflex Impulses in the Spinal Cord of the Frog." Of the eleven theses presented in competition five were sent from England and one from Canada. The subjects of four were morphological, of two bacteriological, of two zoological, one physiological, one was in parasitology and one in physical chemistry.

THE seventh Congress of the International Institute of Sociology will meet in Bern, from July 20 to 24 next at the invitation of the Swiss government. The sessions will be held in the university and under its auspices. Senator Baron R. Garofale, of Venice, will preside, and the subject of social solidarity will be discussed from a variety of wholly scientific points of view. Representatives of many countries, including the United States, will be in attendance. It will be remembered that the last congress was held in July, 1906, at the University of London, under the presidency of the eminent French economist, M. Levasseur, when the opposite question of social struggles was exhaustively canvassed.

THE International Congress of Psychology will hold its sixth meeting in Geneva this year from August 3–7, under the Presidency of Professor Thomas Flournoy. The program, as noted in the *British Medical Journal*, includes discussion of general and special topics, questions of standardization, demon-

stration of apparatus, and individual papers. The general topics to be discussed are feelings (by Külpe and Sollier), subconsciousness (Dessoir, Janet, Prince), measure of attention (Patrizi, Ziehen), religious psychology (Höffding, Leuba). The special topics are the psychopedagogical classification of backward pupils (Decroly, Ferrari, Heller, Witmer), pedagogical psychology (Ioteyko), orientation at a distance (Thauziès), perception of position and movement of the body and limbs (Bourdon). Under standardization will be included terminology, standard colors, enumeration of errors in testimony experiments, notation of age of children, mathematical determination of numerical results of experiments. Communications relative to the congress should be addressed to the general secretary, Professor Ed. Claparède, 11, Avenue de Champel, Geneva.

The skeleton of the fine male *okapi* presented to the Natural History Museum some time since by Major Powell-Cotton has, we learn from the London *Times*, been articulated and put out in the east corridor. The attitude corresponds with that of the mounted skin, for which the museum is indebted to the same donor, the head and neck being nearly in a line with the back. When the *okapi* was described it was believed that the neck was partly raised, and this idea was embodied in mounting the skin of the female presented by Sir H. H. Johnston. It has since been found that the head and neck are stretched forwards. In addition to the two mounted specimens mentioned, the museum has a third, obtained by the Alexander-Gosling expedition, and presented by Mr. Boyd Alexander. This possesses the small bare tips to the horns, which are not developed in Major Powell-Cotton's specimen. In one of the cases of the geological gallery casts of the skull of the *okapi* have been put out by the side of the skull of the extinct *Samotherium*, its nearest ally, for comparison. So close is the resemblance between these two forms that in the official guide to the extinct mammals and birds one species of *Samotherium* is referred to as "an extinct *okapi*."

UNIVERSITY AND EDUCATIONAL NEWS

The recent New York legislature passed the bill providing that the governor of the state shall appoint five members of the board of trustees of Cornell University. The bill to establish at Cornell a state school of sanitary science and public health was not passed. For the general support of the State College of Agriculture, Cornell University, the legislature has appropriated $175,000, an increase over last year of $25,000.

Professor William Nichol, of Kingston, has given to Queen's University, Kingston, Ont., a building for mining and metallurgy, and the Ontario government has appropriated $100,000 for a chemistry building.

At the recent McGill University convocation it was announced that $60,000 had been guaranteed by the committee, which intends to establish a chair in memory of the late Dr. Harrington, professor of chemistry. About $20,000 has already been subscribed and a committee of four has agreed to be responsible for the remaining $40,000.

The Sanders chemical laboratory at Vassar College was dedicated on May 15, when brief addresses were made by the donor, Dr. Henry M. Sanders, of New York; President Taylor, and Professor Charles W. Moulton, head of the department of chemistry.

Dr. Boyd H. Bode, assistant professor of philosophy in the University of Wisconsin, has been appointed professor of philosophy in the University of Illinois.

At Williams College, Dr. F. L. Griffin has been appointed assistant Professor of mathematics; Dr. Brainerd Mears, instructor in chemistry and Dr. J. M. Warbeke, instructor in philosophy.

Mr. J. K. Robertson, of Toronto University, has been appointed lecturer in physics at Queens University.

Mr. Walter K. Van Haagen, B.S., assistant in chemistry, Lehigh University, has been elected associate professor of chemistry in the University of Georgia.

PROFESSOR ERNST LECHER, of Prague, has been called to the chair of experimental physics in Vienna.

DISCUSSION AND CORRESPONDENCE

GENERA WITHOUT SPECIES

IN response to the suggestion made in SCIENCE of February 26, p. 340, I have received a number of communications, in substance as follows:

I agree throughout with your opinions as expressed in SCIENCE for February 26; . . . I hold a genus is not established unless a type species is named.—J. C. Arthur, Purdue University. (Fungi.)

I entirely agree with you that generic names published without any mention of included species are to be regarded as invalid. It seems to me that a genus can not possibly be constituted without reference to a species.—C. J. S. Bethune, Ontario Agricultural College. (Entomology.)

1. A genus is an aggregation of one or more species. The type of a genus is, must be, an included species, that is, an originally included one. Therefore if there are no species at all how is it possible to have a genus? Genera without species are certainly nomina nuda.

2. The author of a genus or species is he who first gives it valid standing. A genus without species is a nomen nudum and thus without valid standing. Therefore the first writer to give it validity is the author and its date is that at which this validating is done. It would be absurd in my estimation to do otherwise as in such case we might have some good genus invalidated through preoccupation by a nomen nudum.—A. N. Caudell, U. S. National Museum. (Orthoptera.)

Mr. Caudell adds that Messrs. Dyar (Lepidoptera, etc.), Knab (Diptera) and Busck (Lepidoptera), of the National Museum, agree with the above statement.

Genera without included species " are nomina nuda."—A. A. Girault, University of Illinois. (Hymenoptera.)

I fully agree with you that the rule of the code quoted by Mr. Coquillett merely means that the genus name itself must be uninominal, and has no bearing on the question under discussion. A genus name without a type species is, I think, untenable; but if it be stated that the genus is founded on an undescribed species, then it might stand as you suggest.—Chas. A. Hart, Ills. State Lab. of Natural History. (Entomology.)

I saw your article in SCIENCE yesterday, and was much interested in it. There are several cases in botany where it seems to me a strict sticking to the letter of the law is a little awkward. Are we to write *Bossekia* Neck. or *Rubacer* Rydb.? It seems to me that Greene has proved that they are the same, yet Rydberg published combinations in *Rubacer* before Greene published them in *Bossekia*.

Mohrodendron and *Carlomohria* are in the same category. Everybody knows what Greene referred to when he published the name, yet he did not make any combinations at that time, and Britton did. If we follow the law exactly in such cases, we are departing somewhat from priority, and it does not seem altogether right to me.—A. A. Heller, Nevada Agric. Exper. Sta. (Flowering Plants.)

On question of validity of generic names when proposed without reference to published description of included species or in connection with such description, please record my vote in the negative. —A. W. Morrill, U. S. Bureau of Entomology.

A genus name can stand only when meeting requirements of binary names, it being recognized that a genus is a group of one or more species.—E. L. Morris, Museum of Brooklyn Institute. (Botany.)

I do not think a generic name should be recognized unless connected definitely with a binomial species. This is in accord with the American Botanical Code and is essential in order to provide types and definitely fix genera.—C. L. Shear, U. S. Dept. Agriculture. (Botany.)

It is probable that generic names published without reference to included species would be rejected by the majority of American zoologists and botanists, though at least some eminent authorities favor their recognition. Probably a more precise estimate of current opinion could be gained by sending out voting papers to all the more active or eminent workers. I venture to suggest that such a plan might be taken up by the American Association for the Advancement of Science. It would not be held or suggested that the votes thus obtained on controversial matters had any legislative significance; but they would undoubtedly have their influence in moulding opinion, while the invitation to vote would in many cases stimulate thought. It seems to me that in the publication of the results of any vote, the names should always be given,

unless the number is very large. In the latter event, representative opinions, with names, could be published.

Whether a plan of this sort could be extended to include the scientific workers of the world (or such of them as might be concerned with the particular matter under discussion) is a difficult question. Efforts of various kinds are being made at the present time to bring the scientific men of the world into closer touch with one another, and it is perhaps not quixotic to suppose that eventually they will be at least as ready and as competent to act together as are those of America at the present time.

T. D. A. Cockerell
University of Colorado,
March 28

THE FUTURE OF NOMENCLATURE

Professor T. D. A. Cockerell's discussion under the heading "Genera without Species" recently published in Science,[1] is of great pertinency at the present time.

Without discussing the question concerning the validity or non-validity of genera described without species named in connection with them, or genera proposed with undescribed types, a question familiar to every systematist, and one which I hope to see discussed by others more competent and learned than myself, I desire merely to make one or two general observations concerning nomenclature as a whole, its function and its future.

Before doing this, however, some remarks concerning the cases considered by Professor Cockerell may not be out of place or without some use.

In the first class of cases, a genus described in the past without a species named in connection with it, I consider as being non-existent—a *nomen nudum*—and it remains such unless subsequently its author or some other refers to it a properly described type species. The genus being non-existent, its name does not have to be recognized again as being that of a zoological unit, excepting as a matter of wisdom; if used again, it has no status unless used as a name based on some definite type species designated subsequent to its original description, and in such cases the original author of the name should be held responsible for it, mainly as a matter of clearness. I agree with Professor Cockerell's interpretation of the code in cases of this kind. Whether or not these *nomina nuda* made in the past should be used again depends largely on circumstances, and is almost a matter of individual judgment. I think they should be used in most cases to prevent questions of obscure homonymy, and confusion arising from other sources. These remarks bring me to the point I had in mind in regard to this class of cases. I have referred to them as occurring in the past. Should they be allowed to occur in the future? There is no excuse at the present time for cases of the kind being made, but some provision should assuredly be made in the code to prevent them. The code should state that after such a date (1900 recommended) genera proposed or described without species named in connection with them should be considered as being without status in nomenclature and ignored accordingly, as newspaper descriptions are ignored. If this is possible, the systematists of the present and future will not have constantly accruing cases of the kind to deal with, or be in danger of their common occurrence, and the old cases would be gradually cleared up.

As to the second class of cases. We may not know, or attempt to define, the exact differences between a species and a genus in monotypical genera; still we do know as a matter of experience that when an author briefly defines a new genus in a diagnostic table of genera of a group and merely mentions a species as type, without describing it and yet follows the rules of binary nomenclature, he has not done all that is necessary to make it recognizable. As a matter of fact, we know that he has not described the species by diagnosing the genus, for the simple reason that the species can not be recognized. As a case in point: In a group of insect parasites of the Hymenoptera, the late Dr. Ashmead, in a table of the genera of a tribe of the Sphegigasterinæ describes or defines a new genus called *Pachycrepoideus*, merely naming a type

[1] N. S., XXIX., February 26, 1909, pp. 339–340.

species in parentheses, without describing it. As defined, the genus was based on but one or two general diagnostic characters. Just recently, I had occasion to deal with the genus in connection with certain parasites of the common house-fly (*Musca domestica* Linnæus); the species of parasite agreed with the brief description of the genus in every particular, as far as it went. The question arose, was it the type species. To decide from the description of the genus was nothing less than pure guesswork. *The generic description or diagnosis did not characterize the species.* Fortunately, I knew that the type species was in the National Museum at Washington and through the kindness of the authorities of that institution I learned that the species which I had under consideration was not only not the type species of *Pachycrepoideus*—a fact which was not strange—but that it differed so much from the genus itself, in other structural, generic characters not mentioned in the description, that it formed a distinct genus in the same division of the tribe.[2] This case is but one in a number of similar ones which occur in the parasitic Hymenoptera. To say that the type species of this genus is described is to say, it seems to me, that naming a thing describes it. To hold such a view is to recommend the practise of naming instead of describing, which is practically what the case just cited amounts to. It is merely another way of saying that to generalize on the whole, is describing and making recognizable all of the component parts. As genera are being described at the present day, even, the practise is a most dangerous one, for unless the type species are soon described they become unrecognizable, the genera practically come under the first class of cases considered, and progress demands a removal of the obstructions and they fall or have to be reconstructed. Future cases of this kind should be prevented.

The main point to which I wish to call attention, however, is not what to do in past cases of the kind considered, but what to do in order to prevent their occurrence in the future. In this matter, we must leave the past behind us and build for the future. Looking ahead, not behind, the whole question of nomenclature turns on a single point, that of identity. If those who come after are to build upon what we are doing in the present, stability in nomenclature will primarily depend on the means we leave behind us for the identification of the things we name. Nomenclature, as we all know, is but the tool, the means to the end of systematic work; the end is fundamentally concerned with identity, identity based on, and dependent upon, definition or description. In the great present-day activity in systematic work, enlightened by past failures and errors, it seems to me to be a deliberate fault for a systematist to cause cases like the kind we have considered. We must all know that what in the far past was regarded as a genus, to-day has become a family or other higher group, and in all probability what is regarded as a genus to-day, in the future may become a much higher group. We have all learned, ere this, that the greatest causes of error, delay and obstruction to progress in systematic zoology at the present time is the meagerness of definition or description of genera and species. Of what use is it to us, to the future, to the race at large, to science, for a systematist, although a recognized authority in the group in which he is working, to describe briefly, unrecognizably, new genera or new species? Does the fact that we know through his efforts that they exist help any of us, help science? Assuredly not; if the units are not recognizable they are nothing more or less than obstructions. Fifty years hence, the systematists will be considering them under the same general classes of cases that we at the present are considering the poorly described genera and species of fifty or more years ago. Having what will then be considered but one or two very general diagnostic characters upon which to base conclusions, in all probability they will be at an utter loss to know into what families or other groups to place them. Of what possible benefit is it, therefore, to describe these things unless we use in every case all the means at our command to make them

[2] I have since learned that my species was the type species of *Pachycrepoideus*. This does not alter the case.

recognizable; will they not in the end become mere *nomina nuda?*

Identity being the fundamental basis of nomenclature, and intimately connected with the end of systematic work itself, it seems utterly absurd to ignore it or to give it but passing attention. Therefore immediate steps should be taken to insure it. Instead of having an international code of nomenclature *recommended* to zoologists, to be followed at their discretion, we have advanced far enough to have one which should be *enforced* by legislation of some such body as the International Zoological Congress, no systematist being recognized unless adhering rigidly to its rulings. At first thought this step may appear to be visionary, as we can not by law control such intangible or incorporeal things as the individual judgments of men concerning what is or is not a good description of a thing; nevertheless, we can prescribe, in cases of the kind considered, what shall or shall not be done in the future. Genera described without species can be rigidly barred; genera described without a description of the type species upon which they are based can be treated likewise. The authors of such genera could be reprimanded or discountenanced, in a sense proscribed. Further a date of departure for a new system of nomenclature based on the future should be designated, for the questions of the past should be studiously avoided in the future, and the new code should be conceived in the spirit of the future, that is to say, in the spirit of expansion, of progress. Such a code, for instance, could provide for the future cases coming under article 21 of the international code, which should be framed along lines tending to make descriptions infinite in detail. For example, an *indication* should not be allowed to hold for present-day or future descriptions and some provision should be made for the compulsory deposition of types in accredited museums. I have mentioned but one or two points which such a code should be expected to cover; for its development and adoption I can hope only; for these few suggestions, I beg the consideration due to the spirit in which they are offered.

The end should always be in mind; we must broaden our view-point; let us look to the future, for properly the present belongs to it.

A. Arsène Girault
University of Illinois,
March 1, 1909

SCIENTIFIC BOOKS

The Origin of the Vertebrata. By Walter Holbrook Gaskell. Longmans, Green & Co. 1908.

Professor Gaskell during the past two decades has published an extended series of papers which have aimed to convert morphologists to the view that vertebrates are descended from arachnids. These papers, with additions and corrections, are now brought together in volume form. We suggest, however, the book's title "The Origin of the Vertebrata" is chosen inaptly. It should have read "The Supposed Arachnid Origin of the Vertebrata," or, better, "A Plea for the Rejected Theory of the Origin of the Vertebrates from Arachnids." For it is hardly fair that the purchaser of this book should believe that he has here a résumé of our knowledge of the ancestry of the vertebrates. He is given merely a one-sided view of the whole intricate problem.

It is just to say that Gaskell has devoted himself generously to the task which he has sought to accomplish. His work shows that he has been earnest and tireless, that his reading has covered a field much wider than that of the usual promoter of a lost cause—that he is not one of those whose effort is measured in terms of success, for he would himself admit that even his friends (and he has many sympathetic ones) in the wide zoological fraternity, do not subscribe (there is scarcely an exception) to a single tenet of his heretical morphology. If he had been trained as a morphologist instead of as a physiologist. perhaps he himself would never have developed his theory.

There has been of late years a tendency to ignore Gaskell's writings on the ground that his arguments, having been weighed carefully, have been found wanting. Then, too, we have lost zest for discussing his difficult theses, *e. g.*, that the arachnid gut and nervous cord fused

to establish the tubular vertebrate nervous system; that the vertebrate gut is a new structure formed by the fusion of the bases of arachnid appendages; that the notochord was later formed from this new gut; that the arachnid genital ducts were retained as the vertebrate thyroid; that the arachnid genital tissue and liver became converted into the arachnoidal fat which fills the brain-case and invades even the skeletal capsule of the vertebrate ear; that Kupffer's sensory plakodes are reminiscent of arthropod appendages; that coxal glands are the homologues of both the pronephros and thymus; that the wide discrepancy in the plan of the embryonic development of arthropod and vertebrate, as in the inversion of the dorso-ventral orientation, is a mere detail caused by the shifting of the mass of the yolk.

One hesitates at this day to reopen an indigestible discussion. And it would be profitless were it not that the volume has brought forward the theory in such a pleasantly written and well-published fashion, which will give it in all probability a wide circulation. The present review need comment on but a few of its teachings—those which touch fundamental conceptions in morphology.

I. Gaskell maintains the doctrine that evolution proceeds (genetically) from the dominant type of one geological horizon to the dominant type of the following geological horizon. This is a doctrine which at the best is intangible and unconvincing. Even the example cited by Gaskell does not support his case—that the vertebrates in their earliest occurrence superseded the sea-scorpions of the early Paleozoic. For at that critical time it was the cephalopods (*e. g.*, the huge Orthoceratids), not the sea-scorpions, which were the dominant race. However, for the sake of argument, granting that the cephalopods are lower than arachnids, they are obviously much higher (measured by the standard of the nervous system) than the lower crustaceans or the worms, hence by the doctrine of dominant types they should have taken an intermediate genealogical position between the crustacea and the arachnids, which even Gaskell would deny.

II. Gaskell seems to have little conception of parallelism, and he is probably, therefore, unaware of the mighty literature dealing with his theme. This is the more regrettable, since it is this principle which bears so directly upon phylogenetic studies. For it can now be demonstrated beyond peradventure that animals, *e. g.*, of different orders, may develop similar structures to such a degree that they are sometimes mistaken for members of the same family or even genus. And if this be true, how can we believe that certain specified resemblances of king-crab to vertebrate can be accepted as tests of genetic kinship? If such a form as a Litoptern can develop many essentials of a horse, yet be not included within the great group of Ungulates, how can we accept Gaskell's elaborate details when he compares forms as widely apart as a vertebrate and an arachnid? An arachnid has no tubular nervous system, no gill slits, no notochord; it has widely different appendages, skeleton, skin, urogenital system, sense organs—how therefore do we venture to compare its details with such vertebrate structures as the abducens, or the various branches of the fifth nerve, or the jaw muscles? We might, in fact, make a comparison of this kind as convincingly, or unconvincingly, by selecting the structures of a cephalopod. In a word, it is this kind of comparison which makes the distressed reader cast down Gaskell's book even when assured by the author that the evidence of these "homologies amounts almost to a certainty."

III. Gaskell fails to take into account a fundamental rule in descent study, that *series* of forms whose structures are the most closely connected should be used for comparisons. This rule he violates constantly when he compares the Paleozoic *Cephalaspis* and the recent lamprey-larva, *Ammocœtes,* for these forms are by no means the nearest links in a possible chain. As a matter of fact, we now known that *Cephalaspis* is but one example of a great group of Paleozoic creatures, that these creatures show the greatest range in forms and structures, and that many of them are unlike arachnids even in superficial regard, in fact some of them are soft-bodied and covered with shagreen like a

shark. It is, accordingly, by no means to be accepted that these creatures are nearly akin to *Limulus*, even if cases of superficial resemblance be pointed out. For the general outward shape of *Limulus* may be acquired independently by creatures of very different groups, even to a certain degree among vertebrates by rays and siluroids. On the other hand, it is clear that ammocœtes should be compared at first not with a Paleozoic form of dubious kinship, but with other cyclostomes, especially with the hag-fishes, which Gaskell rarely mentions. The fact is that after comparison with the latter forms, we are less inclined to regard the ammocœte as a primitive and unmodified creature. For we find that the hag-fishes have no metamorphosis, and we may, therefore, more easily harbor the suspicion that the exceptional sand-living life habit of the larval lamprey has been responsible for many of its curious features, and that these have no wider phylogenetic bearings than have, for example, the peculiar larvalisms developed by many teleosts. But let us not go into details. The momentous problem of vertebrate beginnings is still "on the knees of the gods." We gravely doubt whether Gaskell's book will be of great value in dislodging it.

Bashford Dean

Modern Thought and the Crisis in Belief. The Baldwin Lectures, 1909. By R. M. Wenley. New York, Macmillan. 1909. Pp. ix + 364.

This volume results from the nomination of Professor Wenley by the Protestant Episcopal Bishop of Michigan to give a series of lectures in an endowed course "for the Establishment and Defence of Christian Truth." The circumstance will, perhaps, not especially commend the book to the interest of some readers of this journal. Few ways of spending money seem to some modern minds less desirable, or more productive of ethically awkward situations, than the creation of permanent foundations for scholarly inquiries or discussions, whose results are predetermined by the terms of the endowment supporting them; this is true whether the predetermined result be the truth of Christianity or the truth of socialism. With old foundations of this sort we must do the best we can; but it is a somewhat regrettable anachronism that new ones should appear in recent years, and in connection with American universities. One can hardly suppose that the Christian truths which Professor Wenley establishes and defends would have been recognized as such by the episcopal founder of the lectureship, no longer ago than 1885. The book is almost equally divided into a destructive criticism of religious beliefs still current, and philosophical reconstruction; but one apprehends more clearly what it is that is destroyed than what it is that is constructed. The best, and the longest, division of the book deals with a topic that does not call for discussion here: the religious consequences of historical criticism; the outcome is a frank abandonment of the historical character and content of Christianity, and the transfer of interest from a historic teacher to a "metahistorical Christ." The precise ontological status of this entity, and its relation to the historic Jesus, remain obscure to the present reviewer. The other main division of the book concerns the religious bearings and the philosophic validity of the "natural science view of the world"—the doctrine unfortunately labeled by Ward "naturalism," by which appears to be meant a mechanistic cosmology, biology and psychology taken as equivalent to a complete account of the nature of reality. With this, Professor Wenley vigorously argues, religious thought must now have a definite reckoning; for while historical criticism can destroy nothing essential to religion—since nothing historical *is* essential to religion—naturalism is the "executioner of the ideal life." Since the refutation of naturalism is presented as the main task, not only of this book, but of the present age, one is disappointed to find Professor Wenley devoting expressly to it only some forty pages—one ninth of his space. It should be said, however, that the author regards the task as one for the most part already accomplished, by Ward's "Naturalism and Agnosticism," which he here, so to say, reënacts. His own argument rests chiefly upon two points: (1) Every science begins by deliberately abstracting certain as-

pects of the world from their context, which none the less really conditions them; the conclusions, therefore, of any science become, if generalized and made applicable to the whole, not only inadequate but self-contradictory. (2) Likewise, if the generalized results of science conflict with ideal interests they stultify themselves; for the abstraction from which they arose was for the sake of an ideal. While the reviewer sympathizes with much in Professor Wenley's doctrine, he does not think these arguments calculated to convince. (1) To say that the conclusions reached primarily by segregating and analyzing a certain aspect or type of phenomena are *necessarily* inapplicable and absurd beyond the limits of that segregation, is to say that no unification of knowledge is possible at all. Science assumes that phenomena seemingly complex and diverse can ultimately be understood as special variations—under conditions also generalizable—of a simple and homogeneous type-phenomenon, or of a few such. This assumption is very possibly unwarranted; but it is not comic, and it is not to be disposed of by so easy a piece of dialectic as that employed by the author. (2) Many principles of science are undoubtedly postulated ideal demands. There is no necessary paradox in the opposition of these intellectual ideals to ideals of another order and origin. The question—which this book does not very explicitly discuss—is: When they conflict, which has the right of way?

One could wish that Professor Wenley would be persuaded to chasten his style. At its best it is admirably vigorous and effective; but there are moments in which it seems a cross between the style of the Delphian oracle and that of Mr. George Ade. In such passages the simple, precise and natural expression is laboriously avoided in the interest of strange archaisms and neologisms and a general grandiloquent incomprehensibility. Thus the reader is told that "a mystic element is the *leit motiv* of the fiducial process"; what he is expected to gather is uncertain, but the reference at any rate is *not* to the religious propensities of bankers. One learns of "the æonic means whereby acute need for God is brought home to the secular group"; one is warned that "while it would be sheer ingratitude to lightlie these [historical] investigations, it is quite another affair to train with their representatives when," etc.; one is assured that "God is the normative content of human life"; and one makes the acquaintance of such supernumeraries of our speech as "to gift a procedure" (meaning, simply, to give a procedure), "derivant" (for derivative), "a quantitative phantasmagoria," "misfortunately," "his near kith."

ARTHUR O. LOVEJOY
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ON THE NATURE AND POSSIBLE ORIGIN OF THE MILKY WAY[1]

WHILE the milky way has long been recognized as a relatively thin segment of space in which stars appear more numerous than elsewhere, no satisfactory explanation has been offered for the existence of such a segment with the earth apparently at its center or for any of its characteristic peculiarities of aspect and relationship to the stars as a whole. Noteworthy among the features calling for explanation are the following: The milky way is a belt approximately following a great circle of the sky but broad and diffuse throughout one half of its course while relatively narrow and well defined on the opposite side. The broad half of the belt is cleft in two by a dark lane running along its axis and in addition contains numerous rifts and holes from which the narrow half is relatively free. The number of stars per unit area of the sky is a maximum in the milky way and diminishes progressively on either hand, while the inverse relation is true for the nebulæ, their frequency increasing with increasing distance from the milky way.

It is shown in the present paper that all these peculiarities are immediate results of the supposition that the visible universe consists in the main of two distinct but interpenetrating parts, the first of which is a chaos of indefinite extent in which stars and cosmic

[1] Abstract of paper read at the April meeting of the National Academy of Sciences by George C. Comstock.

dust are distributed with some rough approach to uniformity in general, but with a marked tendency to local aggregations and clusterings. Through this chaos moves the second part, a cluster of stars of great but measurable dimensions, long, broad, but comparatively thin and including the sun as one of its central members. The diameter of this cluster is to be measured in hundreds of light years and throughout at least a large part of its central regions the stars are much more densely clustered than in the external chaos.

In accordance with well-known dynamical laws this moving star stream would operate much after the fashion of a snow plow, sweeping away the cosmic dust from its path and piling it on either hand, above and below the plane of the cluster. The transparent rift thus formed is the milky way through which we see farther and command a view of more stars than through the intensified dust clouds on either side. The dust ejected toward the poles of the milky way constitutes the substance of the nebulæ which there abound.

The narrow half of the milky way is that which lies behind the moving swarm, since here we see the accomplished work of ages and look between dust clouds, long since produced, that converge to a vanishing point. Ahead, in the direction of motion, the work of clearing a path is in progress and relatively near at hand, so that the partially cleared space subtends for us a broader angle, in the midst of which there are collected considerable quantities of primordial dust, the slower-moving particles, which have been captured and permanently annexed by the vanguard of the swarm. The annexed dust cloud constitutes the long cleft in the milky way, while its attendant holes and rifts mark unfinished work on the inchoate side of the galaxy.

The interpretation of the milky way here offered must not be judged solely by its consonance with the phenomena above suggested. It must harmonize with every other fact known about the milky way and it has been the task of the author to seek widely for discord as well as harmony between such facts and the theory above outlined, making the test, wherever possible, a quantitative numerical one. No serious discordance has been found, but the agreement with knowledge hitherto vaguely (or not at all) correlated with the milky way is in some instances striking. Thus the researches of Kapteyn, Eddington and Dyson upon the proper motions of the stars have shown that in the main these bodies belong to two groups in relative motion along the line and in the direction above suggested in explanation of the milky way. Again Pickering has recently announced certain well-marked differences in the distribution of stars of different spectral types, viz., the fainter stars of the galaxy are almost wholly of the first (Sirian) spectral type. The number of stars of the first type increases with diminishing brightness in a four-fold ratio for each successive magnitude, as theoretically it should increase if these stars were uniformly distributed through infinite space. Per contra, stars of the second type (solar) increase from magnitude to magnitude only in a ratio represented by the number 3.25, thus implying a distribution very unlike that of the first type stars. All three of Pickering's propositions, together with similar ones earlier formulated by Seeliger for the totality of stars, without distinction of spectral type, are numerically accounted for by the supposition that the stars composing the primitive chaos are mainly of the sirian type while those of the solar group are predominantly of the solar type. By direct enumeration Eddington finds that this relative predominance of spectral types is shown in the two groups into which the stars are divided with reference to their systematic proper motions.

It is easily seen to be a necessary corollary from this explanation of the milky way that stars in or near the galaxy should on the whole appear to move more slowly across the sky than do similar stars remote from the milky way, and that this predicted result is in fact true has been shown by at least two astronomers. Another interesting corollary may be derived through the supposition that a star belonging to the solar group may by virtue of its motion be made to pass so near to one of the sirian stars as to produce disturbances, one upon the other, that will long remain

marked by some peculiarity of spectrum. If such were the case the stars so marked should be found only in or near the milky way and they should be especially numerous and compactly clustered astern of the solar group, they should be more sparsely distributed ahead of it and should be almost completely lacking on either side of the procession. The so-called Orion stars constitute just such a set of objects, marked and distributed as above and presenting the further peculiarities that their apparent motion across the sky is abnormally small and that their number shows no tendency to increase as we pass from the brighter to the fainter magnitudes. All of these characteristics are such as would be possessed by stars formed as above suggested.

In a somewhat similar class are the new or temporary stars believed to result from collisions of some kind and found only in or near the milky way. Why they are limited to the milky way is now apparent, since that is the region, according to the present hypothesis, in which large relative motions are to be expected.

We may look upon double stars as produced by the close approach of a solar to a sirian star under circumstances such that the gravitational bond between them becomes too strong to be broken and the two bodies abide thenceforth in enforced partnership. The size and shape of the orbits in which they shall move about their common center of gravity are determined by the circumstances of their meeting and an elementary analysis suffices to show that the circumstances that tend to produce a small orbit will equally tend to make that orbit nearly round, while those which make a large orbit will equally tend to make it more pronouncedly oval. A statistical examination of double stars shows that they do in fact show this relation among themselves, a small major axis being predominantly associated with a small eccentricity, an agreement between fact and theory that can hardly be accidental.

The test of a valid theory is its power to coordinate apparently unrelated facts without coming into conflict with any of them and, in view of the illustrations of such coordination given above and of others for which space does not here suffice, there is here presented the concept of a definite group of stars moving through a much more widely extended chaos as the best working hypothesis at present attainable with reference to the stellar system.

BOTANICAL NOTES

OUT OF DOOR BOTANICAL STUDY

WITHIN a few weeks students who are planning out of door study in the summer vacation will decide where they will go. In the hope of being able to help such students to decide wisely we here bring together in summary form abstracts from the announcements made by the directors of half a dozen laboratories.

The oldest laboratory of this kind is the Marine Biological Laboratory at Woods Hole, Mass., whose twenty-second session extends from June 1 to October 1. In addition to instruction in botany, zoology, embryology and physiology, opportunities are afforded for investigation in these departments of biology. For botanical students instruction is offered (1) in the morphology and taxonomy of the algae, and (2) the morphology and taxonomy of the fungi. Five buildings with fifty-five private rooms for investigations, and seven general laboratories, constitute the plant, and are supplied with aquaria, collecting apparatus, reagents and glassware. The laboratory has a steam launch, boats, dredges and the apparatus necessary for collecting and keeping alive material for class use or research. Dr. George T. Moore, of Water Mill, N. Y., is in general charge of the botanical work.

The twentieth session of the Biological Laboratory at Cold Spring Harbor, Long Island, begins July 7 and closes August 21. Opportunities for instruction and investigation in botany and zoology are offered. In botany the instruction includes courses in: (1) Cryptogamic botany—especially algae and fungi, and (2) ecology. The laboratory possesses three buildings for study purposes, supplied with needed appliances, and five dormatories, accommodating seventy-five persons. A 28-foot motor boat, with small boats,

collecting apparatus, etc., are supplied. Professor D. S. Johnson, of Johns Hopkins University, Baltimore, Md., is in general charge of the botanical instruction.

The tenth session of the Harpswell Laboratory at South Harpswell, Maine (sixteen miles from Portland), will be held June 14 to September 11. The laboratory is intended for research students only, and for their accommodation has one building affording facilities for fifteen persons. A motor launch, small boats, nets and dredges are provided for collecting, while in the laboratories are glassware, aquaria, microscopes, microtomes, etc., for the work of investigations. Professor J. S. Kingsley, of Tufts College, Mass., is in general charge of the laboratory.

The Minnesota Seaside Station at Port Renfrew, on the west coast of Vancouver Island, will resume its sessions this year, after a vacation of a year. There are two laboratory buildings, and one dormitory and mess hall, for the use of students. The large brown seaweeds are more than usually abundant along the coast near the station, while the forests of this part of the island are wholly unbroken. The session begins about July 6 and ends about the middle of August. Professor Josephine E. Tilden, of the University of Minnesota, Minneapolis, Minn., is in general charge of this station.

The first session of the Marine Biological Laboratory of the Washington State College will be held at Olga, on Orcas Island, in the northerly part of Puget Sound, beginning June 21 and continuing to July 30. The immediate surroundings include the open waters of the sound with their rich marine flora, the tide flats, open land, forests, nearby freshwater lakes, Mt. Constitution (2,400 ft. alt.) with ravines, waterfalls, swamps, etc. A motor launch, row boats, dredges, collecting apparatus, microscopes, etc., are supplied. Instruction and opportunities for investigation are offered in botany and zoology. Professor R. K. Beattie, State College, Pullman, Wash., is in general charge of this station.

Allied to the foregoing is the Mountain Laboratory of the University of Colorado, whose first session will be held (June 14 to July 24) at Tolland, Colorado, in a mountain park at an altitude of nearly nine thousand feet altitude above sea-level. This point is eighteen miles southwest of Boulder, and is in the midst of hills, mountains, moraines, ravines, brooks, mountain meadows and ponds. The rich forest vegetation of the near-by region, and the "timber line" and alpine vegetation within easy reach, afford many interesting ecological problems. Courses in general biology, nature study, plant ecology, anatomy and taxonomy are offered, and opportunities are given for individual work and investigation. Professor Francis Ramaley, of Boulder, Colo., is in general charge of the laboratory.

SOME SOUTH AFRICAN BOTANY

From far-away South Africa comes a handful of papers by Professor Joseph Burtt-Davey, the agrostologist and botanist for the Transvaal Department of Agriculture. Quite naturally these papers have a strong agricultural bias, yet in all of them the scientific botanist may find much that will throw light upon the native vegetation of the region. One of the most interesting of these papers is that on the "Native Trees of the Transvaal" (1907), in which 269 species, representing 57 families, are recorded, and the additions made during the following year and reported in another paper, bring these numbers up to 336 species and 58 families. These are distributed through four well-marked zones, viz: (1) "The Mist-belt Forest" on the upper eastern slopes of the Drakensberg mountains, where the rainfall is heavy and the atmosphere humid. "A characteristic feature is the evergreen character of the trees, the common occurrence of epiphytes, lianes and ferns":— (2) "The High veld zone," consisting of a typical grass-steppe region, in which trees are rare. It descends to about 4,000 feet altitude: (3) "The Middle veld zone," known also as the "Bush veld," and for the most part loosely covered with trees so as to constitute a "Savannah" region rather than a real forest: (4) "The Low veld zone," restricted to the country lying below 1,500 feet altitude, and also a "Savannah" region.

Looking over the lists one notes species of *Podocarpus* (*Taxaceae*) and *Callitris* (*Pinaceae*), *Phoenix* and *Hyphaene* (*Palmaceae*), many genera and species of *Anacardiaceae, Celastraceae, Ebenaceae, Flacourtiaceae, Leguminosae, Moraceae, Proteaceae* and *Rubiaceae*. Very few of the genera are identical with ours, although one may find such names as *Rhus* (with over 20 species), *Ilex, Diospyros, Euphorbia, Vaccinium, Ricinus, Acacia, Mimosa, Cassia, Ficus, Olea, Rhamnus, Cephalanthus, Xanthoxylum, Salix, Celtis.* Aside from these the genera are quite unfamiliar to the American dendrologist.

The other papers include such topics as the breeding of maize, ramie cultivation, plants poisonous to stock, and the cultivation of alfalfa (lucerne). The latter is very full, and includes over eighty pages, with a number of illustrations.

A NEW BOTANICAL JOURNAL

EARLY in the year (February 27) the first number of a new journal appeared under the name *Mycologia*. On the title-page it is said to be "in continuation of the *Journal of Mycology* founded by W. A. Kellerman, J. B. Ellis and B. M. Everhart in 1885." It is to be "published bimonthly for the New York Botanical Garden." About the middle of April the second (March) number appeared, and we are thus able to judge as to what the new journal is to be like. The first number contains a good colored plate of agarics and pore fungi, and one black-and-white plate. The text includes twenty-six pages, and the articles are entitled "Illustrations of Fungi, I.," "The Boletaceae of North America," "Notes on North American Hypocreales, I.," "A Bacterial Disease of the Peach," "The Problems of North American Lichenology" and "Notes and News." The second number contains one colored plate of agarics and three black-and-white plates, and the text includes forty-six pages. The papers are, "Illustrations of Fungi, II.," "The Hypocreales of North America, II.," "Filling Tree Cavities" and "Notes and News."

The journal is well printed and is a worthy continuation of the *Journal of Mycology*. At the moderate price of three dollars per year it will, of course, be indispensable in every botanist's library.

LEO ERRERA

NEARLY four years ago the noted Belgian botanist Leo Errera died in his forty-seventh year. Born in 1858, he very early displayed a brilliancy of mind which indicated what he was to become in his maturity. Receiving his doctorate from the university, he studied also with Sachs, DeBary, Hoppe-Seyler, Waldeyer, Stahl and others, and became personally acquainted with Bower, Vines, Klebs, Schimper and other noted botanists of Europe. Then began a life of incessant activity, during which he prepared and published nearly three hundred papers. The earliest of these appeared when he was but a youth of seventeen years, while the last ten appeared within a year or two after his death, after having been completed by willing friends.

There is now appearing in Brussels a collection of the works of Errera under the title "Recueil d'Oeuvres de Leo Errera" which is to be completed in six volumes. The papers thus brought together (and they are a selection from all his publications) are of two kinds, viz., (1) those addressed exclusively to specialists in botany and physiology, and (2) those intended for "non-specialists who read and think." Those volumes have already appeared, viz., I. and II., devoted to general botany, and VI., containing miscellaneous papers in prose and verse. The third volume is to be devoted to general physiology, the fourth to philosophy, while in the fifth will be found pedagogical and biographical papers. The beauty of these volumes, their good paper and clear type commend them as a fitting memorial worthy of the man whom they honor.

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SPECIAL ARTICLES

DETERMINATION OF THE COEFFICIENT OF CORRELATION

IN statistical work it is often necessary to determine the coefficients of correlation between a number of variables, the calculation

of which according to the usual method of correlation tables occupies much time, while the subdivision into larger groups makes the results inaccurate. The following method of calculation secures a great saving of time and labor. The averages and mean square variabilities of all the variables must be determined. By forming the differences between any series of pairs, we find the values of $x - y$, which may be treated like any variable. Indicating averages by brackets, we have

$$[(x-y)^2] = [x^2] + [y^2] - 2[xy]$$
$$= \sigma_x^2 + \sigma_y^2 - 2r\sigma_x\sigma_y$$
$$-r = \frac{[(x-y)^2] - \sigma_x^2 - \sigma_y^2}{2\sigma_x\sigma_y}$$

For a single correlation there is not much saving of time in this method of calculation, but in multiple correlations a very large amount of labor is saved.

A similar device may be used in the calculation of correlations of fraternities. When the deviations for members of a fraternity are designated by $x_1, x_2, x_3 \cdots x_n$,

$$[(x_1 + x_2 + x_3 + \cdots + x_n)^2] = n\sigma_x^2(1 + \overline{n-1}r)$$
$$r = \frac{[(x_1 + x_2 + \cdots + x_n)^2]}{n(n-1)\sigma_x^2} - \frac{1}{n-1}$$

A similar method will allow the determination of the average correlation of a large series of variabilities. By reducing each variable to multiples of its variability, we find

$$\left[\left(\frac{x_1}{\sigma_1} + \frac{x_2}{\sigma_2} + \cdots + \frac{x_n}{\sigma_n}\right)^2\right] = n + r_{1,2} + r_{1,3} + \cdots + r_{n-1,n}$$
$$[r] = \frac{\left[\left(\frac{x_1}{\sigma_1} + \frac{x_2}{\sigma_2} + \cdots + \frac{x_n}{\sigma_n}\right)^2\right]}{n(n-1)} - \frac{1}{n-1}$$

Correlations of phenomena that can not be measured, but only counted, may be treated in the following manner: If two events that have the probabilities p_1 and p_2 are correlated, we may say that those cases in which the event 1 occurs have the probability 1, or a deviation from the normal probability $1 - p$.

Those cases in which the event 1 does not occur have the probability 0, or a deviation from the average probability of $-p_1$. If we call p_2' the probability of the event 2 when event 1 occurs, p_2'' the probability of event 2 when event 1 does not occur, and q_1 the coefficient of regression of 2 upon 1, we have

$$p_2' - p_2 = q_1(1 - p_1)$$
$$p_2'' - p_2 = -q_1p_1$$

Thus the phenomenon corresponds strictly to that of measurable variables, and the procedure may be followed that is applied in the calculation of the coefficient of correlation of measurable variables. It follows that

$$p_{1,2} = p_1p_2 + q_1p_1(1 - p_1)$$

We designate, as usual,

$$q_1 = r\frac{\sigma_2}{\sigma_1}$$
$$q_1 = r\sqrt{\frac{p_2(1-p_2)}{p_1(1-p_1)}}$$
$$p_{1,2} = p_1p_2 + r\sqrt{p_1(1-p_1)p_2(1-p_2)}$$
$$r = \frac{p_{1,2} - p_1p_2}{\sqrt{p_1(1-p_1)p_2(1-p_2)}}$$

The correlation between a measurable and an unmeasurable quantity can be determined in a similar manner. When the measurable quantity is grouped as an array of the measurable quantity, we find, using the same symbols as before,

$$[x'] = q_1(1-p)$$
$$[x''] = -q_1p$$
$$\therefore \quad [x'] - [x''] = q_1$$
$$\text{or} \quad q_1 = \frac{[x']p}{p(1-p)}$$
$$r = \frac{[x']p}{\sigma_x\sqrt{p(1-p)}} = \frac{-[x'']\,(1-p)}{\sigma_x\sqrt{p(1-p)}}$$

From these formulas, multiple correlations may be calculated according to the same formulas as those used for measurable variables.

Franz Boas

Columbia University

The Enzymes of Ova—Influenced by Those of Sperm?

Some few summers ago, while working in the laboratories of the Biological Station at Woods Hole, Mass., the writer began some experiments to ascertain whether or not the action of the enzymes of ova were in any measure increased or decreased by those of sperm. The problem was suggested by the work of other investigators which showed that some enzymes have an interdependent action. It was also conceived that the process of fertilization might be due to the acceleration of

the enzyme action of the eggs by virtue of the presence of the enzymes of the spermatozoa. If such were the case the accelerated enzyme action might be demonstrated in the test-tube.

The results of the tests were in no measure conclusive, and the writer had hoped that he would have an opportunity to pursue the problem further, and for these reasons no reports on the investigation were made. As it seems that the work in which the writer is now engaged will prevent his having opportunity to repeat the experiments, a succinct general report of the work will here be made.

Star fish were chosen because they afforded a plentiful supply of both eggs and sperm, and because they were easily obtained from the waters about Woods Hole. The males and females were carefully washed and kept separate. The eggs and sperm were thoroughly ground by mortar and pestle; the power of each to split starch, fat and hydrogen dioxide was tested. Three tubes were used in each case. In tube 1 was placed 5 c.c. of ground eggs, 5 c.c. of starch solution and 5 c.c. of water. In tube 2 was placed 5 c.c. of ground sperm, 5 c.c. of starch solution and 5 c.c. of sea water. In tube 3 was placed 5 c.c. of the ground eggs, 5 c.c. of the ground sperm and 5 c.c. of the starch solution. The tubes were allowed to stand at room temperature for a considerable time, after which the contents were tested for sugar by the reduction test. It was found that there was only the slightest trace of reducing substance in tubes 1 and 2, whereas in tube 3 there was a very distinct amount present. These experiments were repeated perhaps six to ten times and the results were conflicting. They were neither consistently negative nor consistently positive. Nor were they sufficiently often positive to convince one that when they were positive it was not an accident. Comparable experiments to the above were carried out with butyric ether and hydrogen dioxide. The results were equally exasperating as those with starch. Whether the positive results were entirely the result of error or whether the negative results were due to the use of unmatured eggs or sperm it is impossible to say. It seems, however, that the results were such as to justify a careful repetition of the experiments, and it is hoped that some capable man who is interested in the problem will take it up.

It is a well-recognized fact that a large number of the female star fish contain a large number of eggs that appear in every way normal, mature and ready for fertilization and yet will not develop when sperm is placed with them. It seems that it may be possible that this would account for the varying results.

ORVILLE HARRY BROWN

NOTE ON THE ACCESSORY CLEAVAGE IN THE HEN'S EGG[1]

HARPER[2] has shown that polyspermy normally occurs in the pigeon's egg. His figures indicate that from twelve to twenty-five sperm-nuclei are formed in the egg. Only one of these, however, becomes a functional sperm-nucleus; the others migrate from the points of entrance to the periphery of the disc where they become active, dividing and giving rise to the "accessory cleavage." There is thus formed around the primary cleavage, which is produced by the divisions of the segmentation nucleus, an area of small cells. Blount[3] has later shown that these supernumerary sperm-nuclei live but for a short time, and then degenerate. She estimates the time of their disappearance as coming between ten and twelve hours after fertilization.

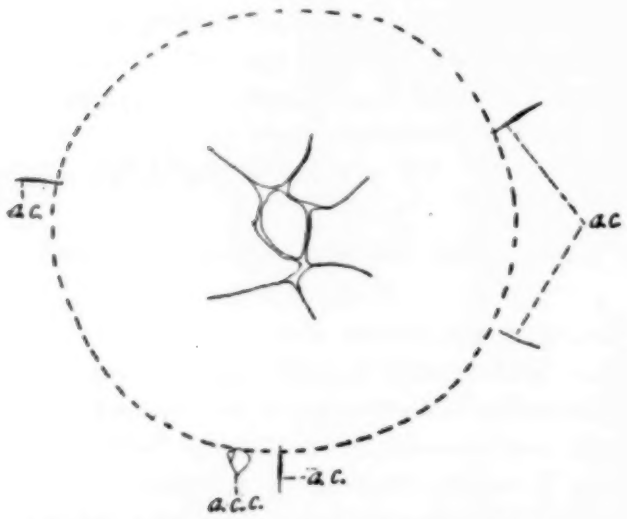
In the hen's egg accessory cleavage has neither been figured nor described. On taking up the study of the early development of this egg I was, therefore, greatly surprised to find an accessory cleavage. Not only can the furrows be seen in the living egg, but I also have preparations of surface views in which they stand out with diagrammatic clearness.

[1] Publications from the Zoological Laboratory of the University of Texas, No. 96. The writer is greatly indebted to the trustees of the Elizabeth Thompson Science Fund for a grant with which to carry on this work.

[2] E. H. Harper, "The Fertilization and Early Development of the Pigeon's Egg," *Amer. Jour. of Anat.*, Vol. III., No. 4.

[3] Mary Blount, "The Early Development of the Pigeon's Egg, with Especial Reference to the Supernumerary Sperm Nuclei, the Periblast and the Germ Wall," *Biol. Bull.*, Vol. XIII., No. 5.

The earliest stage at which I have observed the accessory cleavage is the four-cell. It takes place outside of the area occupied by the primary cleavage, and the planes of the furrows usually coincide with radii of the disc.



Eight-cell stage of the hen's egg. The egg was taken about twenty hours before the time of laying. *a. c.*, accessory cleavage furrows; *a. c. c.*, a small accessory cleavage cell. The dotted line represents the limit of the area of primary cleavage.

The number of accessory cleavages is at no time great. The greatest number so far observed is shown in the accompanying sketch. The actual number, however, may be slightly greater than is indicated by surface views, because in the sections of at least one egg, I have found that not all of the cleavages come to the surface, but some occur in a horizontal plane. That these cleavages are accessory is evidenced by the fact that their accompanying nuclei greatly simulate the supernumerary sperm-nuclei figured by Harper for the pigeon.

Shortly after the stage figured above the accessory cleavages disappear. A detailed study of sections will have to determine whether their disappearance is to be correlated with the degeneration of the supernumerary sperm-nuclei, as reported for the pigeon.

In conclusion it may be said that polyspermy, accompanied by accessory cleavage, normally occurs in the hen's egg. If the number of accessory cleavage furrows may be taken as a general index to the number of accessory sperms entering the egg, it is evident that polyspermy in the hen is not nearly so great as in the pigeon.

J. Thos. Patterson
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THE AMERICAN PHILOSOPHICAL SOCIETY

The general meeting of the American Philosophical Society was held at the hall of the society on Independence Square, Philadelphia, on April 22, 23 and 24. The opening session began at two o'clock on Thursday, April 22, with President Keen in the chair, and morning and afternoon sessions were held on Friday and Saturday. Vice-president Michelson was in the chair during the session devoted to the papers in physics and Vice-president Scott at that at which the geological papers were considered. The evening of Friday, April 23, was devoted to a Darwin celebration commemorative of the centenary of Charles Darwin's birth and of the fiftieth anniversary of the publication of the "Origin of Species," at which addresses made by the Right Honorable James Bryce, the British Ambassador, on "Personal Reminiscences of Charles Darwin and of the Reception of the 'Origin of Species'"; by Professor George Lincoln Goodale, of Harvard, on "The Influence of Darwin on Natural Science," and by Professor George Stuart Fullerton, of Columbia, on "The Influence of Darwin on the Mental and Moral Sciences."

On Saturday afternoon there was a symposium on earthquakes at which papers were presented by Professor Edmund O. Hovey, Professor William H. Hobbs and by Professor Harry F. Reid. Aside from the three papers presented at the Darwin celebration on Friday evening, forty-four papers were read at the morning and afternoon sessions. A list of these papers with a brief summary of their contents follows:

The American-British Atlantic Fisheries Question: Thomas Willing Balch, of Philadelphia.

This controversy, which is more than a century old, will shortly be submitted to The Hague International Court for settlement. As in the case of the Alaska frontier, where Canada's land claims grew greater with the passing of years, so in this fisheries dispute the position of America on the one hand and of Great Britain, Canada and Newfoundland on the other, is admirably summed up in the words with which the Russian plenipotentiary, Count Nesselrode, defined the positions and arguments of Russia and England when they were discussing the Russo-British American frontier: "Thus we wish to conserve and the English companies wish to acquire."

The Nation and the Waterways: Professor LEWIS M. HAUPT, of Philadelphia.

A philosophical discussion of the relation of the states and the national government in relation to the waterways of the country, in which it was pointed out that the lack of a proper distinction between local, state and national improvements has led the government to assume jurisdiction over all waterways and has thus retarded the symmetrical development of the trunk lines in connection with their feeders by the inability to systematically exclude all these works at the same time. The remedy must lie in the restriction of the governmental control to the strictly interstate waterways or trunk lines and principal harbors, while the states should charter, as in times past, local corporations to develop their own internal avenues of trade and power, as has been so satisfactorily done in relation to the overland highways of commerce and is still the practise in New York, Illinois, Massachusetts and other states.

Why America should Reexplore Wilkes Land: EDWIN SWIFT BALCH, of Philadelphia.

Lieutenant Charles Wilkes, U.S.N., first announced to the world in 1840 the existence of a great Antarctic continent, along whose shores he sailed for a distance of 1,500 miles. This coast is known as Wilkes Land. It has not been visited again. Sir James Clark Ross, R.N., Sir Clements R. Markham, ex-pres. R.G.S., and Captain Robert F. Scott, R.N., neither of whom has been there, declare emphatically that Wilkes Land does not exist and should be expurgated from the charts. It should, therefore, be looked on as a patriotic duty for America to verify Wilkes's discovery and get a more careful chart of its shores.

Many of the early discoveries in West Antarctica were made by American sealers, by Swain, Palmer, Pendleton, Morrell and Smiley. Now all their discoveries are being verified and enlarged by men of other nations. The same thing will happen with Wilkes's discoveries in East Antarctica, if America will not wake up. An expedition to verify Wilkes's discoveries would cost perhaps $100,000; and the best way to start it might be by forming an Antarctic committee, composed of representative scientists and explorers, who would take hold of and push this matter.

At the conclusion of the reading of Mr. Balch's paper the society adopted the following resolution, presented by Rear-Admiral Geo. W. Melville, Mr. Henry G. Bryant and Mr. E. S. Balch:

WHEREAS: The United States in former years made many brilliant discoveries in the Antarctic, including the continent of Antarctica by Charles Wilkes, and

WHEREAS: The United States have not taken any part in the recent scientific explorations of the South Polar region; therefore be it

Resolved, That the American Philosophical Society requests the cooperation of the scientific and geographical societies of the United States, to urge on the navy of the United States and through the general government, that it do make sufficient appropriations to fit a government vessel to thoroughly explore and survey the coast of Wilkes Land, and other parts of Antarctica.

The Volcanic Formation of Java: HENRY G. BRYANT, of Philadelphia.

An account of Mr. Bryant's explorations of the volcanic formations of the island of Java, illustrated by photographs taken by the author.

Machines and Engineering in the Renaissance and in Classical Antiquity: Professor CHRISTIAN HÜLSEN, of Rome.

A description of the methods and engines employed in moving great weights and performing other engineering feats that excite our admiration in the works of antiquity. A precursor of the automobile, a "walking chair," was described, that was operated by man power. The illustrations were drawn from contemporary sources, the earlier from monuments and carvings and the later from prints and drawings, and in many cases contemporary descriptions were cited.

The Brains of Two White Philosophers and of Two Obscure Negroes: Professor BURT G. WILDER, of Ithaca, N. Y.

The brains of Chauncey Wright and of James Edward Oliver were compared with the brains of two obscure negroes, one a mulatto, the other black. The very unusual gyral simplicity of Wright and the mulatto may have a physiologic significance. The black's brain is comparable with Oliver's and is considerably larger than that of a late prominent politician. These and other paradoxes exemplify the importance of securing a large collection of human brains, especially of educated people, for study and comparison.

In discussion, Professor E. A. Spitzka emphasized the need of more material and stated that the average negro brain is smaller than the average Caucasian.

Some Conditions Modifying the Interpretation of Human Brain Weight Records: Dr. H. H. DONALDSON, of Philadelphia.

An account of the brain weight records that have been collected at the Wistar Institute of Anatomy. After the fifteenth year up to the fifty-fifth, the human brain loses slightly in weight and then more rapidly after that period. This slight loss in weight between the fifteenth and fifty-fifth years is attributed to the influence of those diseases which ultimately end in death.

New Evidences as to the Physical Basis of Heredity: Professor Edwin Grant Conklin, of Princeton.

Some Notes on the Modifications of Color in Plants: Professor Henry Kraemer, of Philadelphia.

The problem of modifying plants in a particular direction is attended with much difficulty, yet we see in nature numerous modifications which are due to the environment, or to external factors, although it is claimed by some modern evolutionists that none of the modifications due to food or to change of locality are permanent.

After reviewing the previous work on the control of color in plants, and enumerating the factors which influence the color in flowers, the author gave the results of his own experiments, which were begun in the autumn of 1904 and have been continued up to the present time. Various soils were experimented with, including an artificial soil, and sand to which a special nutrient was added. The chemicals used to modify the color principles were supplied to the plants in the form of solutions of varying strength, or added to the soil in the solid form, solution gradually taking place.

Results with Roses.—Probably the most striking result which the author obtained by the use of chemicals was the production of a red color in the petals of the white rose, Kaiserine. The red pigment occurred in the basal portion of the petals, and was produced in the flowers of plants which were supplied with potassium hydrate, potassium carbonate, calcium hydrate and lead acetate. It should be stated in this connection that the Kaiserine rose tends to yellowish but not to pink or red, and therefore the red color produced in the petals is a new character. Two explanations for its occurrence are suggested: (1) either the added chemical has reacted directly with a compound already present in the petals, or has induced the formation of an entirely new substance; or (2) the color substance formed in other parts of the plants, as in the leaves, has been transported to the petals through the influence of the chemical.

Results with Hydrangeas.—Since July, 1907, the author has been experimenting with the red-flowering form of *Hydrangea* (*H. Otaksa*). The following results have been obtained: Blue flowers were produced by plants growing in both sand and garden soil when supplied with the following chemicals: potassium and aluminum sulphate, aluminum sulphate and calcium hydrate. In those plants which were grown in sand and which were supplied with nutrient and potassium carbonate, blue flowers were also produced.

The flowers remained pink or red either when growing in soil or when growing in sand and fed with nutrient and supplied in addition with iron and ammonium sulphate, or lead acetate. In the plants fed with lead acetate the original color was considerably intensified.

In the case of the plants growing in soil and supplied with potassium carbonate there was no change in color, that is, the flowers remained pink, due probably to absorption of the chemical, while as noted above the flowers were changed to blue when growing in sand and supplied with this chemical.

Comparative Leaf Structure of the New Jersey Strand Plants: Professor John W. Harshberger, of Philadelphia.

Professor Harshberger classified the floral zones of the New Jersey coast district into four regions or "formations"; (1) the *beach*, (2) the *sand dune*, (3) the *thicket* and (4) the *salt meadow* formations. The character of the flora of each region was dwelt upon, and the leaf structures of the plants adapted to each habitat were described and illustrated. Professor Harshberger believed that studies of this character were necessary to indicate what kinds of plants would have to be grown, if an attempt to reclaim these regions were to be made.

The Composition of Chrysocolla: Professor Harry F. Keller, of Philadelphia.

Under this head are included various hydrated silicates of copper, which are amorphous and of rather indefinite composition. The color of these varies from green to blue. The author described a well-characterized variety from Chile, which forms enamel-like crusts of turquoise blue color, having the composition of an acid silicate with two molecules of water of crystallization. He expressed the opinion that the variation in color must be ascribed to the differences in the amount of water of crystallization, the blue varieties containing two molecules while the green varieties contain but one. He is also of the opinion that

many of the varieties analyzed contained admixtures of foreign substances.

The Chemical Work of the U. S. Geological Survey: FRANK WIGGLESWORTH CLARKE, of Washington.

An account of the admirable chemical work of the Geological Survey Laboratory, of which Professor Clarke is the chief, with a review of the more important results of this work.

Recent Work on the Physics of the Ether: PAUL R. HEYL, of Philadelphia.

Considerable interest has been taken of late in the question as to whether the ether is or is not a dispersive medium with regard to light. The work of the speaker, published about a year and a half ago, leads to the conclusion that any dispersion in the ether must be less than one part in 250,000. Since that time others have arrived at the conclusion that there exists a dispersive effect of much smaller magnitude, about one part in a million. There seems to be no doubt of the correctness of their observations, but it is not clear that it is to be attributed to a real dispersive effect in the ether. It is more likely that it is due to tidal phenomena in the atmosphere of the variable stars used as sources of light in the experiments.

The Effect of Bleaching Powder upon Bacterial Life in Water: Professor WILLIAM PITT MASON, of Troy, N. Y.

The extraordinary bactericidal effect of free chlorine or of bleaching powders used in minute quantities in drinking waters was described and it was suggested that an emergency plant for the manufacture of chlorine for this purpose should be attached to the municipal water supplies.

The Detonation of Gun Cotton: Professor CHARLES E. MUNROE, of Washington.

In the use of gun cotton in mines and torpedoes advantage is taken of the discovery of Mr. E. O. Brown that gun cotton which is completely saturated with water may be detonated by the detonation of dry gun cotton in direct contact with it used as a "priming charge," thus securing a large margin of safety for the naval vessels carrying the explosive. Wet gun cotton containing as high as 35 per cent. of water has been shown to be a more efficient rupturing and shattering explosive than dry gun cotton, but the question of how much water the discs of priming gun cotton may contain to be efficient was the object of the research detailed in this paper. The primer was in all cases fired by the service detonator containing 36 grains of mercuric fulminate. The results show that detonation of the entire charge was effected in every case in which the primer contained less than 12 per cent. of moisture, and occasionally was complete in cases where the moisture ran as high as 15 per cent. and therefore that such gun cotton primers containing not more than 12 per cent. of moisture, fired by means of a detonator containing 36 grains of mercuric fulminate may be relied upon to detonate wet gun cotton with which they are in contact.

The Toxodontia: Dr. W. J. SINCLAIR, of Princeton.

South American Fossil Catacea: Dr. FREDERICK W. TRUE, of Washington.

Dr. True remarked that in connection with a revision of the fossil whales and porpoises of the United States he had had occasion to examine various specimens from Patagonia, including some belonging to Princeton University and to the American Museum of Natural History. Among the former, he found a skull of a new genus allied to the large porpoise of the Amazon River, known as the inia, but very much larger. The principal specimen from the American Museum of Natural History was a very finely preserved skull of a little-known genus, *Diochotichus*. This skull is remarkable in possessing large openings through the ethmoid plate, indicating that this porpoise, unlike modern forms, probably possessed a brain with an olfactory lobe and well-developed olfactory nerves, and hence, was endowed with a good sense of smell.

The Patagonian fossil cetaceans thus far known are from the provinces of Santa Cruz and Chubut, and are believed to belong to the Tertiary Epoch. At all events, some of the genera are the same as those found in the Miocene formations of Maryland, New Jersey and other Atlantic coast states.

Some of the Patagonian forms belong to families still represented in South America by living species. Others represent families no longer existing. The fossil fauna includes sperm whales, various forms allied to the inia, others allied to *Squalodon*, and at least one species of whalebone whales, allied to the finbacks, but no ziphioid, or beaked, whales nor any true dolphins have been found.

The Destruction of the Fresh-water Fauna of Western Pennsylvania: Dr. ARNOLD E. ORTMANN, of Pittsburg.

The fresh-water fauna forms part of our natural resources. That it has been injured and partly destroyed by the advance of civilization is well known, but it is not realized how far the destruction has advaneed. Since a number of fresh-water creatures are of economical value

(fishes, mussels), and since all creatures belonging to the ecological community of the fresh-water are mutually dependent upon each other, it is very desirable that the causes which lead to the destruction of fresh-water life should be removed.

These causes are: direct extermination by man; pollution of the streams; and river "improvements," as, for instance, the building of dams. The pollution of the water is the most important cause, and, in western Pennsylvania, it is chiefly the coal mining and the oil industries which have contributed to the deterioration and destruction of the fresh-water fauna.

The extent to which this contamination of the waters has been carried in western Pennsylvania was clearly laid down on a map.

The Stratigraphic Position of the Oolitic Iron-ore at Bloomsburg, Pa.: Gilbert Van Ingen, of Princeton.

A study of the so-called "Clinton fossil iron ores" in the vicinity of Bloomsburg, Pa., shows that these oolitic areas are above the Shawangunk grit and conglomerate which is Lower Salina in age, and that they are certainly above the Lower Salina. They contain an extensive fauna and the paleontological evidence points to a Salina age, at least post-Clinton and post-Niagara.

A Mechanical Device for the Tabulation of the Sums of Numerous Variable Functions: Professor Ernest W. Brown, of New Haven.

On Certain Generalizations of the Problem of Three Bodies: President Edgar Odell Lovett, of Houston, Texas.

Penrose's Graphical Method of Orbit Computation: Mr. Eric Doolittle, of Philadelphia.

The method shows how, when the exact position of a moving comet or planet among the stars has been observed on three or more nights, the path of the body can be determined and also the position which the body will occupy as viewed from the earth at any desired time. But little computation and no knowledge of higher mathematics is necessary in applying the method which well illustrates the principles of more intricate methods and also enables the position of the body in the sky to be predicted with sufficient accuracy to render it easily found in a telescope at any time.

On the Remarkable Changes in the Tail of Comet C. 1908 (Morehouse), and on a Theory to Account for these Changes: Professor E. E. Barnard, of Yerkes Observatory, Williams Bay, Wis.

Professor Barnard exhibited a remarkable series of photographs made with the photographic telescopes at the observatory, showing changes that occurred in the tail of this comet which appear to indicate resistance to the passage of the body through space. In discussion of the paper it was suggested that this resistance might arise from clouds of meteoric dust, too fine to be visibly appreciable, but which might still be dense enough to offer a resistance that would account for the changes in the form of the tail of the comet that were shown by the photographs.

The Past History of the Earth as Inferred from the Mode of Formation of the Solar System: Dr. T. J. J. See, of U. S. Naval Observatory, Mare Island, Cal.

Linear Resistance between Two Parallel Conducting Cylinders: Professor A. E. Kennelly, Harvard University, Cambridge, Mass.

The equipotential surfaces perpendicular to the lines of flow between two equally and oppositely charged parallel wires of very small radii are cylinders whose axes are in the plane of and parallel to the charged wires. If any of these cylinders were made conducting and the charge on the wire within transferred to it, the lines of flow and equipotential surfaces on the outside would remain the same. Hence the resistance between any two such cylinders can be expressed in terms of their radii and the distance between their centers. The equivalent linear resistance between two equal cylinders or of one cylinder and the medium plane may be simply expressed as a product of its circumference and a function of its radii and the distance of its center from the plane.

Vacuum Effects in Electrical Discharge around a Right Angle in a Wire: Professor Francis E. Nipher, of St. Louis.

On the Ruling of Diffraction Gratings: Professor Albert A. Michelson, University of Chicago, Ill.

The paper gave a brief statement of the development of the grating, mentioning the ingenious wire grating of Fraunhofer, the improvements of Rutherford, and the magnificent gratings of Rowland. These were sufficient in their day, but problems connected with more recent researches like the Zeeman effect and phenomena of that nature demanded a much greater resolving power. In this connection it was pointed out that the important fact was not so much the number of rulings per inch as the total number of rulings, and that this greater number of rulings necessi-

tated a correspondingly greater degree of regularity—an accumulated error of one ruling in the entire number being fatal.

The ruling engine now set up in the Ryerson Laboratory gives this necessary increase in perfection of ruling, so that the spectra are almost free from ghosts and those of the higher orders can be used. The resolving power is proportional to the product of the total number of rulings into the order. A photograph of a part of the Hg spectrum was shown, in which the distance between two of the lines was only one two-thousandths of the distance between the Na D lines, and it was evident that lines separated by only one half of this distance would be distinctly resolved.

This ruling engine is the result of seven years' work. The large ten-inch gratings are ruled on metal to save the cutting edge of the diamond, and weigh about thirty pounds. The greater part of this weight is supported by a float in mercury, only a small part pressing upon the ways. It is moved along the ways by a screw with a large head working by fine teeth in an automatically actuated worm. This screw was made as perfect as possible by long, careful grinding and the remaining errors which are of the order of the one millionth part of an inch are automatically compensated for by a slight tangential motion of the worm. This motion is a function of the position of the nut, determined empirically.

On an Adjustment for a Plane Grating Similar to Rowland's for the Concave Grating: Professor CARL BARUS, assisted by M. Barus, of Providence.

By using two slides, one symmetrically normal to the other, and observing on both sides of the point of intersection, it is shown that many of the errors are eliminated by the symmetrical adjustments in question. The slide carrying the grating may be provided with a focusing lens in front, or again behind it, if the means are at hand for actuating the slit, which is not sharply in focus throughout the spectrum at a given time, on the plane of the eye piece carried by the second slide. It is thus best to use both lenses conjointly, the latter as a collimator and the former as an objective of the telescope in connection with the eye piece. The authors show that a centimeter scale parallel to the eye piece slide, with a vernier reading to millimeters, is sufficient to measure the wave lengths of light to few Angström units, while the wave lengths are throughout strictly proportional to the displacements along the scale. The errors of the three available methods and their counterparts are discussed in detail.

The Electrometer Method of Standardizing the Coronas of Cloudy Condensation: Professor CARL BARUS, of Providence.

The author makes use of Thomson's method of measuring the charge of an electron in terms of the velocity of the ions and their number. The latter, however, are determined from the angular diameter of the coronas of cloudy condensation, produced in a cylindrical fog chamber under given conditions of rapid exhaustion. By providing the chamber with a charged axial aluminum tube closed within, and charged or not with sealed tubelets of radium acting through the aluminum walls in virtue of its beta and gamma rays, the fog chamber becomes an electrical condenser with a variable ionization. The electrical current passing from core to the shell of the cylindrical condenser may therefore be simultaneously measured by a sensitive electrometer. If it be assumed that negative ions only are caught in the fog chamber used and if the author's earlier and independent results are employed for stating the nucleation value of the coronas, the following data are typical for the enormous ionizations produced:

Total number of ions per cub. cm. = 1,700,000, 385,000, 135,000.

Corresponding value of ten thousand million times the electrical charge = 4.4, 3.6, 3.9 electrostatic units.

The author discusses the results critically and shows that the displacement of ions during exhaustion is the most serious source of discrepancy. Again that in a house in which a continuous lighting circuit terminates, it is absolutely essential to determine both the positive and negative current in the condenser separately, as they are liable to be widely different. On the other hand, the effect of gamma rays on the outside of the fog chamber and of conduction currents is almost negligible for a well-installed apparatus.

The Electrometric Measurement of the Voltair Potential Difference between Two Conductors of a Condenser containing a Highly Ionized Medium: Professor CARL BARUS, of Providence.

Solar Activity and Terrestrial Magnetic Disturbances: Dr. L. A. BAUER, of Washington.

This paper deals with the connections between the various manifestations of solar activity, *e. g.*, sun-spots, and the so-called magnetic storms which at times affect compass needles simultaneously all over the earth by several degrees and even cause

serious interruption in telegraph and cable lines, and are usually accompanied by fine auroral displays. One of the most severe of these magnetic storms was that of October 30–November 1, 1903, which was violent enough to derange the mariner's compass at certain places by as much as 3° and even was said to have caused a temporary suspension of the electric car lines in Zürich, Switzerland. The effect from this particular storm lasted for fully two months after its apparent subsidence, the earth's magnetic condition being *below* normal until towards the close of the year (1903).

Renewed interest has been shown by the recent discoveries of Professor Hale, director of the Carnegie Solar Observatory at Mount Wilson, Cal., viz., that sun-spots are centers of violent cyclones and that they are accompanied by powerful magnetic fields. But however intensely magnetic these whirling cyclones may be, a simple calculation shows that they are far too distant to appreciably affect our most sensitive magnetic instruments.

Yet the various curves exhibited show indisputably that some relation exists between solar activity, as evidenced, for example, by sun-spots, calcium flocculi, solar eruptions, prominences, etc., and the earth's magnetic fluctuations. The variations in the solar and the terrestrial magnetic phenomena follow each other closely. One of the most important of the conclusions drawn is, that an *increase in sun-spot activity is accompanied by a decrease in the earth's magnetization, or that the magnetization superposed on the earth's magnetic field during solar outbreaks is opposite to that of the earth's own field.*

It appears questionable whether the earth's magnetism ever settles down precisely to its former condition after the occurrence of a magnetic storm.

The facts are not yet sufficient to draw a definite conclusion whether solar activity and magnetic storms stand to each other as cause and effect or whether they are both effects of the same cause. The indications are, that during a period of intense solar activity, in some as yet unknown manner, considerable fluctuations are caused to take place in the electric field that we know from various facts exists in the regions above us. These varying electric currents in turn affect the magnetic needles on the earth's surface.

On the Hevelian Halo: Professor Charles S. Hastings, of New Haven, Conn.

The paper reviewed the various kinds of halos that have been described and the explanations that have been offered in regard to their origin. It had been assumed by writers on the subject that the snow crystals, which are in the form of plates or prisms, would fall with the plate or prism presenting the least resistance to the air. Thus, according to this idea, the hexagonal plates would fall edge on and the prism end on. This was shown to be incorrect and the contrary was the case, the plates and prisms could fall through the air with their longer dimensions horizontal. The plates would assume a horizontal position as well as the prisms. The halo was then caused by total internal reflection from the plates or prisms and not by surface reflection. Assuming these general positions for the long or short prisms (or plates) and total internal reflection the various types of halo that have been described could be explained, with the exception of the Hevelian halo. To explain this on the basis of total internal reflection it was necessary to assume pyramidal planes in the crystal of such an angle as to produce the 90 degree halo of this rare type.

The Effect of Temperature on the Absorption of Certain Solutions: Professor Harry C. Jones, of Baltimore.

An account of experiments on the absorption spectra of certain solutions which Dr. Jones is carrying on under the auspices of the Carnegie Institution of Washington, D. C. Increase of temperature of the solution was found to alter the absorption spectra in the same way that they are changed by concentration of the solution.

The Specific Chemo-therapy of the Protozoal Diseases: Dr. Simon Flexner, of the Rockefeller Institute for Medical Research, New York.

The Unsuspected Presence of Habit-forming Agents in Beverages and Medicines: Dr. Lyman F. Kebler, of Washington.

The paper considers the increased use of various habit-forming drugs. Attention is called to the fact that a large number of soft drinks contain not only a considerable amount of caffein, but in many instances small quantities of cocain. The presence of cocain has also been found in a considerable number of agents intended for the treatment of the tobacco habit. The presence of the same pernicious drug has been revealed in medicine used in the treatment of hay fever, asthma and for relieving pain resulting from dentition in infancy. The presence of morphine, opium, chloral hydrate, heroin and codein, singly or combined, has also been found in many other medicines, particularly those intended for the treatment of epilepsy, rheumatism, asthma, gastric troubles and ailments of infancy and childhood.

SYMPOSIUM ON EARTHQUAKES

Introduction, Classification, Discussion of Volcanic Earthquakes, Description, with Illustrations, of the Charleston, S. C., and Kingston, Jamaica, Disasters: Professor EDMUND O. HOVEY, New York.

The Present Status and the Outlook of Seismic Geology: Professor WILLIAM H. HOBBS, of Ann Arbor, Mich.

Conditions Leading to Tectonic Earthquakes—Instruments used in the Study of Earthquakes—Suggestions for a National Seismological Bureau: Professor HARRY F. REID, of Baltimore.

Professor Hovey's paper served as an introduction to the subject. The ideas in regard to the cause of earthquakes were considered, especial attention being given to a discussion of volcanic earthquakes. Professor Hovey described the Charleston and Kingston earthquakes and illustrated his description by lantern slides. At the conclusion of his paper he exhibited a series of views of the Messina earthquake of December, 1908.

Professor W. H. Hobbs spoke of the manner in which the subject of seismology had been retarded by the publications of Robert Mallet, who advocated the idea that the shock originates at some point underground called the seismic focus or centrum, and from which center elastic waves are propagated in all directions. Professor Hobbs pointed out the fact that the "centrum" as determined by the method of Mallet was at best a line and practically had no existence. He explained the production of earthquakes by the shifting of segments of the crust along already existing fissures due to geotectonic movements, and insisted upon the tectonic origin of earthquakes. Volcanic activity and earthquake activity may be associated, as volcanoes are located along lines of fissure in the crust. Release of strain by shifting of the crust blocks, accompanied by earthquakes, as has been going on in the earthquake regions surrounding the Pacific Ocean in the last few years, probably produces in such a region an establishment of approximate equilibrium so that earthquakes may not be so severe for some time. The probability of earthquakes occurring in a given region may be tentatively predicted by a study of such crustal adjustment, but such predictions must be considered as tentative only. The upward or downward movement of the surface during earthquakes may be considerable, producing raised beaches, as has recently occurred in the Alaskan Islands. Along some coast lines the evidence of such movement is to be seen in the raising of sea caves, and also the undercut portions of sea-cliffs, above the water level. As these movements involve many feet of elevation during an earthquake, perhaps the ideas of Lyell on the rate of changes of level of the land and sea may have to be modified.

Professor Harry Fielding Reid considered three phases of the subject: (*a*) conditions leading to tectonic earthquakes, (*b*) instruments used in the study of earthquakes, (*c*) suggestions for a national seismological bureau.

(*a*) The rocks have the properties of elastic substances and can only break after they have been deformed by the action of external forces. When they are strained beyond their strength a break occurs and the rocks return to an unstrained position, but it is only in the general neighborhood of the rupture that any distinct displacement takes place at the time of the earthquake.

(*b*) Earlier investigators attempted to obtain a "steady point"; that is, a point which would remain at rest when the earth vibrated under the earthquake disturbances. This, however, is impracticable. All earthquake instruments must have a proper period of vibration and when the disturbance affects them the resulting record is a combination of the movement of the earth and the movement of the instrument. When the period of vibration approaches that of the instrument, the latter has a very large swing and therefore the records unduly magnify special vibrations. This can be avoided by introducing strong damping. The different forms of instruments were briefly noticed.

(*c*) The work of a national bureau would be very varied. It would require the collection of data regarding all felt earthquakes, and a geological examination, in special cases, of the regions where earthquakes occur. The instrumental records from the whole country should also be collected and studied to throw light on the nature of the earth's interior, and to discover the centers of earthquake disturbances in the surrounding oceans. This would require the general cooperation of many departments of the government and could probably be best undertaken by the Smithsonian Institution.

At the conclusion of the discussion following the symposium Professor Hobbs presented the following resolutions, which were unanimously adopted:

WHEREAS: Earthquakes have been the cause of

great loss of life and property within the territory of the United States and its possessions, as well as other countries; and

Whereas: It is only through the scientific investigation of the phenomena that there is hope of discovering the laws which govern them, so as to predict their occurrences and to reduce the danger to life and property; and

Whereas: Such investigations can be successfully conducted only with the support of the general government, be it therefore

Resolved, That this society urge upon Congress the establishment of a national bureau of seismology, and suggest that this bureau be organized under the Smithsonian Institution with the active cooperation of the other scientific departments of the government, and that this bureau be charged with the following duties: (*a*) the collection of seismological data, (*b*) the establishment of observing stations, (*c*) the organization of an expeditionary corps for the investigation of special earthquakes and volcanic eruptions in any part of the world, (*d*) the study and investigation of special earthquake regions within the national domain, and

Resolved, That copies of these resolutions be transmitted to the president, the speaker of the house of representatives, to the president of the senate and to the secretary of the Smithsonian Institution.

The Evolution of the City of Rome from its Origin to the Gallic Catastrophe: Professor Jesse B. Carter, of Rome, Italy.

An attempt to sketch in its outlines the development of the city of Rome from its origin to the Gallic catastrophe. The original people lived in little communities upon the hilltops, each community surrounded by a circular wall or stockade. The geological character of the campagna and its topography produced a number of elevations admirably adapted for such settlements. All of these little hilltop towns must have been very similar in population and customs and no one was probably a leader among them. Their consolidation into a city is assigned to the influence of an invasion by the Etruscans who conquered these hill towns, and enclosed them along with their intervening valleys with one wall. Some villages remained without the wall, as suburbs to be afterwards incorporated in the city; such were the Aventine region and the Campus Martius. The city had then outgrown its original dimensions and was no longer all within walls, which accounts for the ease with which it was captured by the Gauls in 390 B.C. With the capture of the city by the Gauls Rome enters upon her period of inviolability for almost eight hundred years and the thought suggests itself irresistibly that the reputation for inviolability thus gained may have been a large factor in preserving her inviolate. Even in their early days the city began to be "that so holy spot, this very Rome."

On the Extent and Number of the Indo-European Peoples: Professor Maurice Bloomfield, of Baltimore.

The Burning Bush and the Origin of Judaism: Professor Paul Haupt, of Baltimore.

The Israelites probably never saw Egypt. The so-called Israelites who were in Egypt were the descendants of Esau, the Edomites. The burning bush was explained as the shrubbery on the heights of a volcano, lighted up at night by the glow of the incandescent lava. The story of the pillar of cloud by day and pillar of fire by night was not that it hung over the tabernacle but over Mount Sinai, the cloud of steam from the active volcano was the "pillar of cloud by day and the pillar of fire by night." The myths in regard to the destruction of Jericho and of Sodom and Gomorrah were attributed to the effect of earthquakes.

Magic and Religion: Professor Edward W. Hopkins, of New Haven.

Milton's Confession of Faith: The Identity of Religious Belief between Milton and George Fox: Alden Sampson, of Haverford, Pa.

J. J. Rousseau, a Precursor of Modern Pragmatism: Professor Albert Schniz, of Bryn Mawr, Pa.

At the Darwin commemorative meeting, after the presentation of the three addresses attention was called to the fact that there were two members of the American Philosophical Society still living in England who were friends of Charles Darwin—Sir Joseph Dalton Hooker and Dr. Alfred Russel Wallace—and on motion it was unanimously resolved that the society should cable to them its greetings and congratulations on the general acceptance of the views in the elaboration and promulgation of which they had taken such an effective part.

Early in the day a telegram was sent to Vice-president Simon Newcomb conveying to him the society's good wishes and greeting and their regret that he could not be present at the meeting.

The meeting was largely attended by members from various parts of the country and was regarded as most successful both from the point of

view of the quality of the papers read and the number and broadly representative character of the members who took part in it.

The sessions closed with a dinner at the Bellevue-Stratford, on Saturday evening, April 24, at which about one hundred members were present and at which the speakers were: President Patton, of Princeton; the British Ambassador, Mr. Bryce; President Pritchett, of the Carnegie Foundation; President-elect Lowell, of Harvard, and President Keen, of the American Philosophical Society.

The annual election of members held at the executive session on Saturday, April 24, resulted in the election of the following candidates:

Residents of the United States.—Louis A. Bauer, Ph.D. (Berlin), Washington, D. C.; Marston Taylor Bogert, New York; Hermon Carey Bumpus, Ph.D., New York City; Alexis Carrel, M.D., New York City; Edwin Brant Frost, Williams Bay, Wis.; Robert Almer Harper, Ph.D., Madison, Wis.; William Herbert Hobbs, Ph.D., Ann Arbor, Mich.; A. V. Williams Jackson, Ph.D., LL.D., Yonkers, N. Y.; John Frederick Lewis, Philadelphia; Abbott Lawrence Lowell, Boston, Mass.; William Romaine Newbold, Ph.D., Philadelphia; Charles Bingham Penrose, M.D., Ph.D., Philadelphia; William Howard Taft, Washington; Charles Richard Van Hise, M.S., LL.D., Madison, Wis.; Victor Clarence Vaughan, M.D., Sc.D., LL.D., Ann Arbor, Mich.

Foreign Residents.—Francis Darwin, M.A., F.R.S., Cambridge, Eng.; Hermann Diels, Ph.D., Berlin; Emil Fischer, Ph.D., M.D., Berlin; Friedrich Kohlrausch, Ph.D., Marburg; Wilhelm F. Ph. Pfeffer, Ph.D., Leipzig.

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

ON the evening of Monday, March 1, the regular meeting of the Academy of Science of St. Louis was held at the Academy Building, the feature of the program being a paper, read by Mr. Julius Hurter. The subject of the discourse, which had been compiled by Mr. Hurter and Mr. John K. Strecker, Jr., was "The Amphibians and Reptiles of Arkansas."

After stating that up to the present time definite records are obtainable from only 15 of the 75 counties of Arkansas, Mr. Hurter recorded the facts that 100 species of reptiles and amphibians have been reported from Arkansas, and 90 from Missouri. Thirteen of the Arkansas species are not known to occur in Missouri, and nineteen are not found in eastern Texas. Most of the species are eastern and southeastern forms which find their western limit in Arkansas and the eastern half of Louisiana. Another interesting fact brought out was this—that of the 71 species occurring in both Arkansas and the eastern half of Texas, 63 are also found in the state of Missouri. Mr. Hurter showed numerous specimens in illustration of his paper, and also the blind salamanders of the world: *Proteus anguinus* (European blind salamander), *Typhlotriton spelæus* (Missouri) and *Typhlomolge rathbuni* (Texas).

At this meeting, on proper motion, duly seconded and unanimously carried, the following memorial was adopted as expressing the views of the academy; and copies were ordered sent to the speaker of the house of representatives, the president of the senate, and the gentlemen who represent Missouri in both branches of the present Congress:

"The Academy of Science of Saint Louis, an organization equally interested in the preservation and the proper and consistent utilization of the gifts of nature, respectfully urges on the Congress of the United States the desirability of promptly passing the House Joint Resolution now under consideration as a means of continuing the provisions of the Burton Bill, limiting the diversion of water from Niagara Falls, until equally effective but more permanent protection of the Falls shall be secured by adequate legislative or executive action."

THE program of the meeting of the Academy of Science of St. Louis which occurred on March 15 was a paper by Mr. Otto Widmann on "The Birds of the Missouri Botanical Garden." In twenty visits to the garden during the summer of 1908, Mr. Widmann noted forty species of birds breeding there, and six species which were more or less regular visitors from near-by breeding grounds. And, besides these, there were scores of transient visitants during the migratory seasons. The breeders are the bob-white, mourning-dove, screech owl, yellow-billed cuckoo, black-billed cuckoo, red-headed woodpecker, northern flicker, chimney swift, kingbird, great crested flycatcher, wood pewee, Traill's flycatcher, blue jay, crow, cowbird, red-winged blackbird, meadow lark, orchard oriole, Baltimore oriole, bronzed grackle, goldfinch, English sparrow, English tree sparrow, chipping sparrow, song sparrow, towhee, cardinal, rose-breasted grosbeak, indigo bunting, warbling vireo, Bell's vireo, yellow warbler, yellow-throat, yellow-breasted chat, mockingbird, catbird, brown thrasher, house wren, wood thrush and robin.

Of the whole bird population of the garden, only four species are permanent residents. And these are the bob-white, flicker, mockingbird and redbird. The regular visitors are the sparrow-hawk, king-fisher, night-hawk, humming-bird, purple-martin and cedar waxwing. The numerous hedges of dense shrubbery harbor Bell's vireo, yellow warbler, Maryland yellow-throat, chat, Traill's flycatcher and the indigo bunting. In the arboretum are found the crested flycatcher, wood pewee, wood thrush, cuckoos and the gentle mourning doves. The meadow has attracted quails and meadowlarks. The ripening mulberries are an attraction for flocks of cedar birds in early June, and the many beautiful flowers charm numberless hummingbirds later in the summer.

Thirty or more species of birds were on exhibition to illustrate Mr. Widmann's paper.

At this meeting the following resolution was adopted: "On the recommendation of its entomological section, and with approval of its council, the Academy of Science of St. Louis, on duly seconded and passed motion at its regular meeting of the fifteenth of March, 1909, respectfully urges on the members of the General Assembly of the State of Missouri, the importance of passing House Bill No. 575, and Senate Bill No. 197, providing the adequate inspection of nursery stock. At the present moment the entire orchard and nursery industry of the state is imperiled by a threatened introduction of the dreaded brown-tail moth, in the bare restriction of which New England has for years waged a costly warfare. Nothing but adequately planned and efficiently administered state inspection can protect this important industry of Missouri in the present or in future crises."

On April 5, the Academy of Science of St. Louis met to hear a paper presented by Prof. Whinthrop Holt Chenery, of Washington University, on "The Relation of the Physiography of the Iberian Peninsula to the Development of the Spanish and Portuguese Peoples." Mr. Chenery considered the distinguishing features of the peninsula—topographic, geological and climatic—and their significance as determining factors in the historical evolution of the peoples. In particular he showed that the chief occupations of the inhabitants, ever since prehistoric times, have been determined by the physical character of the country; and that the long-continued prevalence of these occupations has produced widely divergent types of people.

The lecture was fully illustrated, and insistence was laid upon the importance of the study of physical environment to the understanding of the Spanish-Portuguese history.

W. E. McCourt,
Recording Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 664th meeting was held April 10, 1909, Vice-President Wead in the chair. Two papers were read.

An Approximate Method of Analysis of E.M.F. Waves: P. C. Agnew.

A knowledge of the impurities present in the E.M.F. wave given by a generator is required in many engineering and physical problems. While a large number of methods have been devised for the analysis of such E.M.F. waves, those methods which give quantitative results require highly specialized and expensive apparatus. The experiments described were undertaken to determine if it is possible to obtain reliable results by the use of condensers and portable indicating instruments only.

For the same effective voltage, a distorted wave will pass more current into a condenser than will a pure sine wave. We ought, then, to be able to use this fact to determine the amount of impurities present in a given wave. Obviously a greater accuracy can be attained if we make the analysis depend on bridge values of resistance, inductance and capacity, and so make it independent of the absolute calibrations of the voltmeter and ammeter used. This may be accomplished by replacing the condenser by a resistance and adjusting to give the same readings of ammeter and voltmeter. We may consider that each component of voltage, e_n, causes the corresponding component of current, i_n, to flow. The square of the effective value of current indicated by the ammeter is equal to the sum of the squares of the components. If in the case of the presence of the nth harmonic only, C represents the capacity, L the inductance, r the resistance, and if p is 2π times the frequency,

$$I^2 = \frac{e_1^2}{r^2 + (pL - 1/pC)^2} + \frac{e_n^2}{r^2 + (npL - 1/npC)^2}.$$

Now on removing the condenser and increasing the resistance to R, we have, for the same readings of voltmeter and ammeter,

$$I^2 = \frac{e_1^2}{R^2 + p^2L^2} + \frac{e_n^2}{R^2 + n^2p^2L^2}.$$

From these relations we get the ratio of the harmonic to the fundamental E.M.F.,

$$\frac{e_n}{e_1} = \frac{\sqrt{1/a_3 - 1/a_1}}{\sqrt{1/a_2 - 1/a_4}}.$$

where a_1, a_2, a_3, a_4, have been written for the four impedances in the denominators above.

While theoretically the method may be extended to any number of harmonics, it is practically limited to two by the accuracy of readings and by the labor of computation. Experiments in the analysis of waves built up by combining the E.M.F.'s of different machines, and also by the analysis of E.M.F. waves of single generators, show that the method is capable of an accuracy of two or three per cent. of the fundamental.

The method has the disadvantages of giving no information of the phase relations, and of not readily lending itself to the analysis of current waves. The advantages are that it requires no special apparatus; direct access to the generator, or the use of synchronous motor, is not necessary; and the accuracy is better than that of an oscillograph, though not equal to that of a curve tracer.

The Accurate Analysis of Alternating Current Waves: F. W. GROVER.

With the rapid development, in recent years, of methods and apparatus for the tracing of alternating current waves, the question of the convenient analysis of the curves obtained has become increasingly important. Although the well-known method of Fourier is the most direct and accurate, its employment seems to be quite generally regarded as too laborious for general use. This is evidenced by the appearance of a number of graphical and planimetrical methods, among which may be mentioned those of Clifford, Fischer-Hinnen, and Houston and Kennelly. All these modes of procedure, however, labor under the disadvantage, inherent in all graphical methods, of inaccuracy where small quantities are involved, without any saving of time over that required to derive the values of an equal number of harmonics by the Fournier analysis if the calculation be suitably arranged.

In 1897 Rosa simplified the calculation by the use of a table from which the required products of the ordinates by the sines of the angles could be taken directly from a table. Using this, all the odd harmonics up to and including the 15th can be obtained in a little over an hour.

S. P. Thompson[1] showed that the work could be still further shortened, (1) by grouping together those ordinates which are to be multiplied by the sines of the same angle, and (2) by dividing the half wave into an even number n of equal parts, when the products divide themselves into complementary groups, so that the kth and $(n-k)$th harmonics are found, respectively, by adding and subtracting the sums of two groups of products. He gave the complete scheme of calculation for the two cases, $n=6$ and $n=12$. The whole analysis in the former case may be carried through in ten minutes or even less.

The electromotive force waves of alternators with slotted armatures, however, often contain the higher harmonics to an appreciable extent, and these may greatly distort the form of the current wave in circuits containing capacity. The speaker has therefore developed the scheme of calculation for the case of 18 ordinates and has prepared a table to facilitate the multiplications. Such a table need include the ordinates up to 100 only, the fractional parts being found from the same table by shifting the decimal point. Using this method the amplitudes of all the harmonics up to and including the 17th may be determined in about half an hour with an accuracy and ease not attainable by any graphical method.

R. L. FARIS,
Secretary

[1] *Electrician*, May 5, 1905.

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 458th meeting was held April 3, 1909, with President Palmer in the chair. Lantern slides made by a novel application of well-known methods were shown upon the screen by Mr. A. A. Doolittle. The silver is thoroughly removed from plates, leaving only the gelatin film; from old, unused or undeveloped plates by the usual hypo bath, and from poor or waste negatives by the reducing process with ferri-cyanide. On immersing the thoroughly washed plate in blue print solution for five minutes and subsequent drying in the dark, they may be printed upon by contact with negatives in the usual manner. They give clear high lights and contrasting effects, desirable qualities in lantern slides or transparencies. The color is a pleasing semi-translucent blue. The method is simple and can be used by the inexperienced. Beautiful window transparencies are similarly made.

The following communications were presented:

Classification of the True Fishes: THEODORE GILL.

The speaker restricted the class Pisces to the true fishes or Teleostomes, as he had done since 1873. Two of the best zoologists of Europe (Hubrecht, of Holland, and Regan, of the British Museum) have recently come to the same con-

clusion. Regan has also recently (January, 1909) published on "The Classification of Teleostean Fishes" and admitted four subclasses of Teleostomes and 31 orders of Teleosts. The four subclasses are the same as four of those recognized by the speaker in 1896; a fifth then admitted in deference to the general sentiment at that time (Hyoganoidea) may now be suppressed. Remarks were made on the contrast between the orders recognized till past the middle of the last century and those now admitted by Mr. Regan and the speaker. Praise was accorded to Regan for his work, but the speaker was disposed to dissent from him as to certain groups and presented the following list of orders. Those named without synonyms are the same as Mr. Regan's; the synonyms added after many are the names given by Regan. It was especially insisted upon that the list was only provisional and tentative and that no significance need be attached to the exact position or sequence of some of the orders. The author is now employed in further studies of the osteology.

Our knowledge of the extinct types is in such an unsatisfactory condition that the present list is restricted to the living forms.

Class Pisces

Subclass Dipnoi or Dipneusti.
- Order Sirenoidei.

Subclass Crossopterygii.
- Order Semæopteri or Cladistia.

Subclass Chondroganoidei.
- Order Chondrostei.
- Order Selachostomi.

Subclass Teleostei.
- Order Rhomboganoidei or Ginglymodi.
- Order Cycloganoidei or Protospondyli.
- Order Malacopterygii or Isospondyli.
- Order Iniomi.
- Order Scyphophori (S. O. Mormyroidei).
- Order Plectospondyli (S. O. Cyprinoidei).
- Order Nematognathi (S. O. Siluroidei).
- Order Symbranchii.
- Order Carencheli.
- Order Apodes.
- Order Lyomeri.
- Order Opisthomi.
- Order Heteromi.
- Order Lyopomi (Heteromi pt.).
- Order Xenomi (S. O. Dallioidei).
- Order Haplomi (Microcyprini).
- Order Synentognathi.
- Order Salmopercæ.
- Order Percesoces.
- Order Rhegnopteri (S. O. Polynemoidei).
- Order Acanthopterygii (Labyrinthici + Malacichthyes + Anacanthini + Allotriognathi pt. + Berycomorphi + Heterosomata + Percomorphi + Batrachoidei).
- Order Hemibranchii (Thoracostei + Solenichthyes pt.).
- Order Hypostomides.
- Order Lophobranchii (Solenichthyes Solenostomoidei and Syngnathoidei).
- Order Discocephali.
- Order Chondrobrachii.
- Order Tæniosomi (S. O. Trachypteroidei).
- Order Atelaxia (S. O. Stylophoroidei).
- Order Xenopterygii or Xenopteri.
- Order Plectognathi.
- Order Pediculati.

The Guano-birds of Peru: Robert E. Coker. (Illustrated with lantern slides.)

The chief guano-producing birds in order of importance are—a cormorant (*Phalacrocorax bougainvillei* Less.), the pelican (*Pelecanus molinæ* (Molina) Gr.) and a gannet (*Sula variegata* Tsch.). A small petrel (*Halodroma garnoti* Less.) has some significance, and, if earlier accounts are accepted, it was formerly much more abundant and important. The penguin (*Spheniscus humboldti* Meyen) was reputed to be commercially important a few decades ago. Other interesting birds were observed on and near the islands.

The pelican has suffered most from the disturbance incident to the extraction of guano from the rookeries. The bird has been practically eliminated from the small islands of the southern region, but still breeds in great numbers on the larger islands of the north. A colony of pelicans, between twenty and forty thousand in number, was observed on the Lobos de Afuera Islands. Since 1906 the Peruvian government has enforced a "closed" season of five months annually, but it is expected that a more adequate plan of rotation will be adopted, so that the birds on certain islands may be undisturbed for periods of years. In partial adoption of this plan, the South Island of the Chincha group has been kept "closed" for nearly three years. It is estimated that, by the expiration of the three years, a deposit of twenty thousand tons will have accumulated upon this island.

The 459th meeting was held April 17, 1909, in Hubbard Memorial Hall, with President Palmer in the chair. The evening was devoted to a lecture by Mr. Charles Sheldon, of New York, on "Experiences with Big Game in the Mt. McKinley Region, Alaska," illustrated by a large number of stereopticon views of the country and of mountain sheep, caribou, moose, lynx, bear and ptarmigan.

M. C. Marsh,
Recording Secretary